SCIENTIFIC AMERICAN SUPPLEMENT. No. 1084

Copyright, 1896, by Munn & Co.

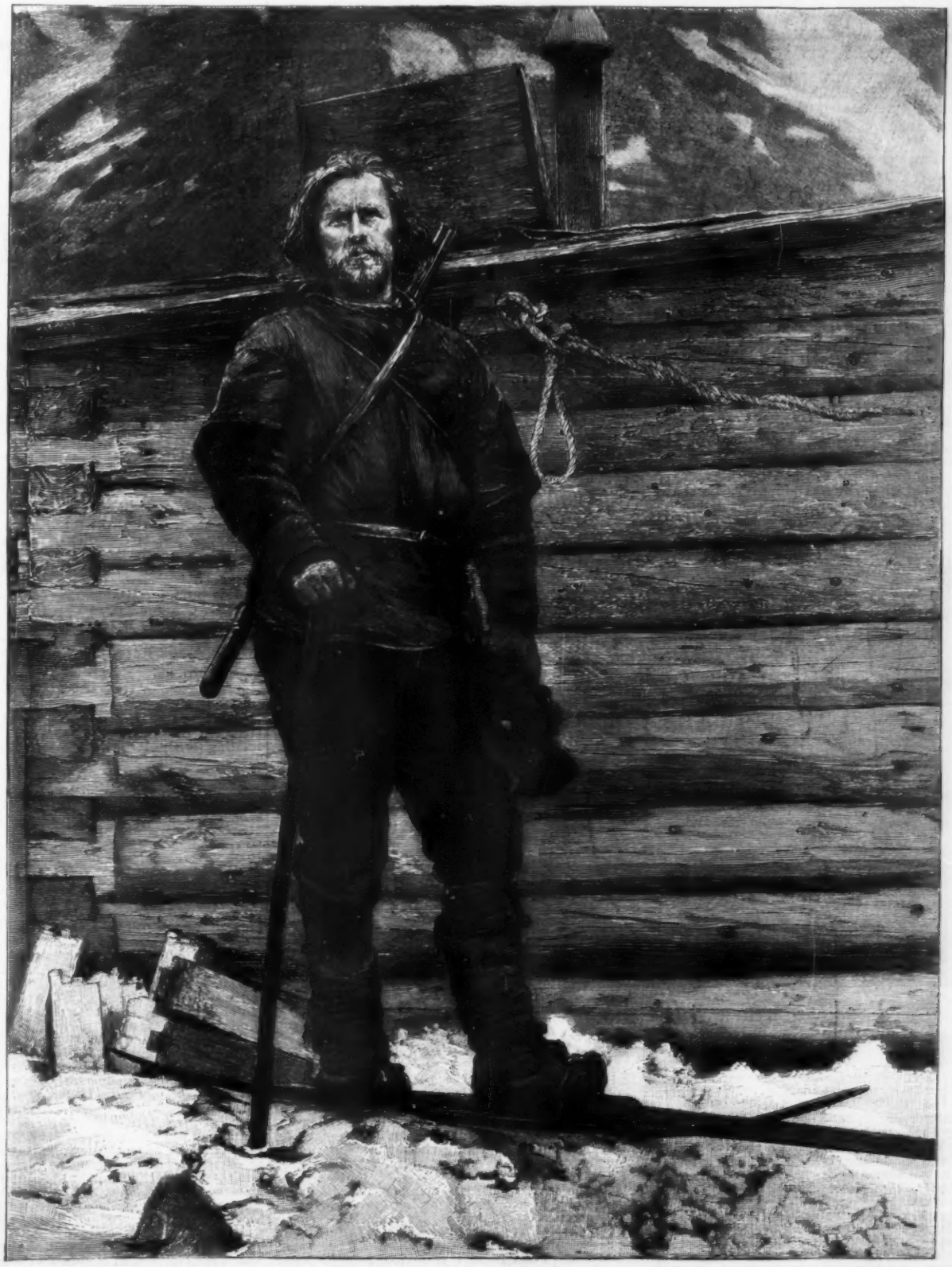
Scientific American, established 1845.
Scientific American Supplement, Vol. XLII, No. 1084. NEW YORK, OCTOBER 10, 1896. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

JACKSON AND NANSEN IN THE WHITE NORTH.

ONE of the most dramatic incidents in the whole history of Arctic exploration was the meeting of Jackson and Nansen—a meeting which had its counterpart when Stanley found Livingstone in equatorial Africa. We have already traced in detail the wanderings of Dr. Nansen in the far north, and it is pleasant to be able to tell the story of this remarkable meeting from authentic memoranda.

Nansen and his solitary companion were on the desolate shores of Franz Josef Land, their kayaks were lashed together, and over them a kind of tent was erected. Lieut. Johansen was asleep while Dr. Nansen was busy preparing the frugal breakfast. Suddenly he heard the bark of a dog, he aroused his companion, a consultation was held and it was decided that Nansen should go on shore while Johansen stayed by the boats. He landed, and three hours passed, then Johansen descried a man walking in the distance. He did not think that it was Dr. Nansen; so he fastened a Norwegian flag to a stick and waved it aloft. The stranger at once hastened to the shore and greeted Johansen warmly; this was Mr. J. W. Child, of the Jackson-Harmsworth expedition. Talking was a difficult matter, as neither spoke the other's language, but in a few minutes some members of the Jackson party came up, some of whom spoke German. The party cheered the Norwegian flag, then all started for Mr. Jackson's headquarters at Cape Flora.

Meantime Nansen had met Jackson. One of the members of the Jackson-Harmsworth expedition came into the tent and said that there was a man out on the ice. It was little wonder that Mr. Jackson was greatly astonished. He rushed out and ran down the ice to dis-



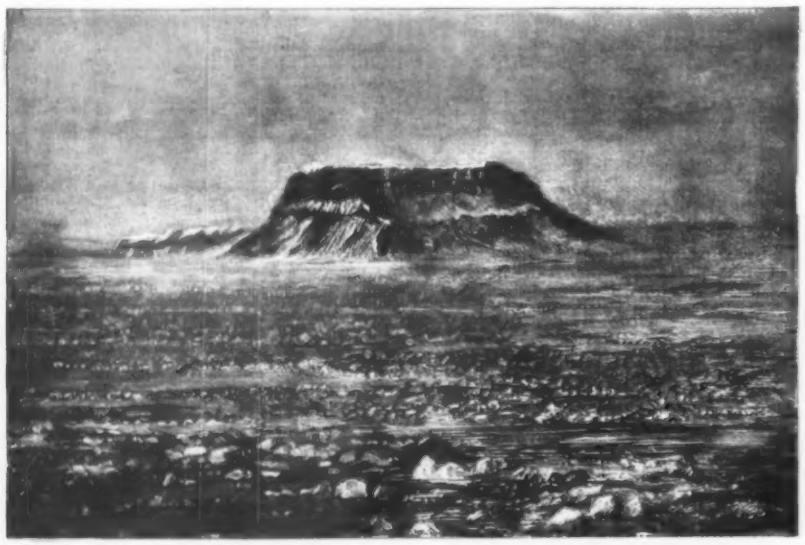
DR. NANSEN AS HE APPEARED WHEN MET BY MR. JACKSON IN FRANZ JOSEF LAND.
From a photograph taken by Mr. Jackson on their arrival at Elmwood.

cover who the stranger might be. Certainly his nearest relations would not have recognized Dr. Nansen. He was absolutely black from head to foot, his light hair and mustache were jet black and there was not a speck of white about his face or hands. The brightness of his eyes were accentuated by the grime of his face, which had been blackened by the blubber smoke. His clothes—the one suit which he had worn for fifteen months—were stiff with blood and oil, with which his face and hands were also covered. It is little wonder that for a moment, Jackson failed to recognize the brave Norwegian he had known. He looked at the uncouth stranger and then exclaimed:

"Are you Nansen?"

"Yes," was the reply. "I am Nansen."

"I am really awfully glad to see you," said Jackson. Then the Norwegians were taken to Elmwood and photographed in all their grime, after which they indulged



CAPE GRANT AND BELL ISLAND.

in the luxury of a warm bath and were bidden to a feast such as the Arctic regions have rarely seen.

The gallant explorers lived together for six weeks before the Windward came, and during this time Dr. Nansen enjoyed the hospitality of the Englishman. That great men have great hearts is shown by the unselfishness which each explorer exhibited. Nansen was unwilling to include in his map that portion of Franz Josef Land through which he passed, since it already had been mapped by Mr. Jackson. This was only exceeded by the generosity of the man into whose field of geographical research he had unconsciously wandered. Mr. Jackson says:

"I have given him tracings of my map and his route south. Armitage and I have helped him in his map as much as we could. I have also offered him the naming of the locality about his route, as, owing to his not having met with land elsewhere, he would not have had much, if any, opportunity of remembering his friends in his map."

It would be interesting to have had a Boswell in attendance during the long weeks before the Windward came. The explorers went out shooting, they worked on their maps and made memoranda, and the whole time was spent in a manner which is in sharp contrast to the bickerings and unpleasantnesses which have distinguished some of the recent Arctic expeditions.

Our engravings, for which we are indebted to the London Graphic, give the appearance of Dr. Nansen when he was met by Mr. Jackson in Franz Josef Land; they also show Cape Grant and Bell Island photographed at a distance of seven miles by Mr. Jackson with a telephotographic lens, and Elmwood, the most northerly British settlement in the world. Mr. Jackson's winter quarters shown in the engraving consist of seven huts; and during the winter the clearing away of the snow from these huts gave the men the regular daily exercise so necessary to their health.

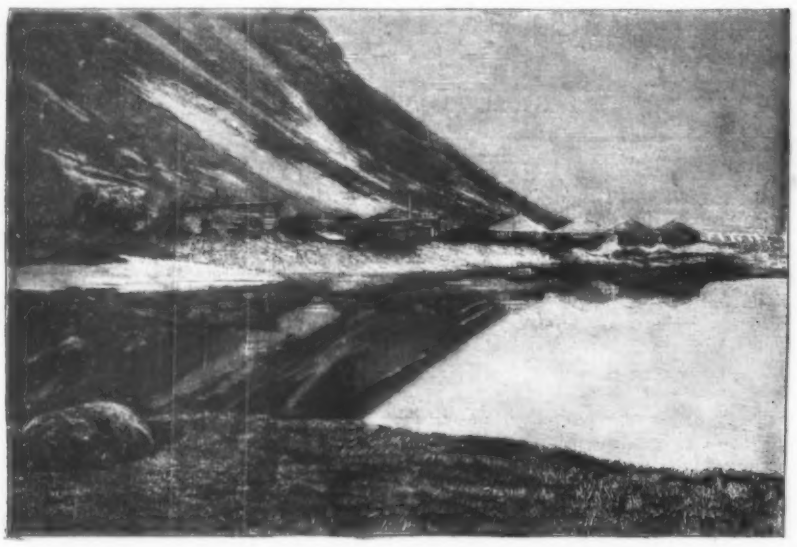
The fame of Nansen has perhaps eclipsed unduly the good work which the Jackson-Harmsworth expedition has been doing. Mr. Jackson's work in the far North, says the Graphic, has been of a very different character to that of Dr. Nansen.

The Norwegian's programme involved from the point of departure an immediate advance to the unknown North. Mr. Jackson's, on the other hand, necessitated (as he showed in his paper before the Royal Geographical Society on the eve of his departure for the Arctic regions) the careful and methodical exploration of the little known Franz Josef Land—the mapping of its coasts, the exploration of its interior, and the proving, once and for all, whether Franz Josef Land was the southern limit of a polar continent or whether it was a mere collection of islands in the vicinity of the Pole. The munificent patron of the expedition is Mr. Alfred Harmsworth.

From the reports sent home this year it will be seen that Mr. Jackson has almost completed this first chapter in the history of the expedition he commands. "The net results," he writes, "of this spring journey have been to confirm some of the more important discoveries of last year, and to produce a map of Franz Josef Land which for the first time lays down with approximate accuracy its geographical outline and, at the same time, entirely alters the previous records. By following for two successive years practically the same plan of exploration, I have been able to check and confirm the discovery I announced last year, have swept away a great body of supposed land, and substituted for it a number of small islands and a large and important sea. To this—Queen Victoria Sea—I look as my most favorable route northward next year, for I consider that when the sun returns next spring the mapping of Franz Josef Land will be practically complete, and, having done this, nothing should prevent my attempting its open waters or crust of ice, as the case may be."

This is the way, we may remember, in which the knowledge of all Arctic geography has been slowly and painfully acquired. But it is evident that Mr. Jackson has in contemplation yet another chapter. For, when he has conscientiously mapped and examined the archipelago of Franz Josef Land, it is obvious from his letter that he intends to hazard the chance of a voyage northward. That great sea, the southern shores of which he has trod, over whose wide expanse he has gazed from a lofty cape, and whose nameless waters he has loyally christened after his sovereign, will probably prove his avenue of approach to land or sea in a far higher latitude even than that he has already attained, and possibly lead him to discoveries of greater importance and into a region which no rival, however friendly, shall have reached.

Mr. Jackson had explored the coasts of the most northerly land yet known to exist nearly four months before Dr. Nansen came down there from the higher latitude which he had attained by marching over the ice some hundred miles away to the east; he had given the names of the "British Channel," and the "Queen Victoria Sea," to the waters he found opening northward, beyond the "Austria Sound" of Payer, adding to these designations, at successively observed recesses or interruptions of the water space, in what is likely to be an archipelago with many smaller islands, the English-honored and home-remembering names of "Clements Markham Bay," "Allen Young Sound," "Robert Peel Sound," and of "Cape Albert Markham," "M'Clintock," "Sybil Montefiore," and those of islands, "Mary Elizabeth," after his own mother; "Scott Keltie," but lastly, that of "Frithiof Nansen," happily associated with this nomenclature of the Franz Josef Land archipelago by the Norwegian explorer's descent upon its shores. Henceforth, being so far made acquainted with what is undeniably proved to be "the most important body of water in this part of the Arctic regions," to the north of the Old Continent, we may anticipate a corresponding extension of the general scope of Arctic exploring work on the other sides, or from other points of the circumference of the Polar Circle.



ELMWOOD, THE MOST NORTHERLY BRITISH SETTLEMENT IN THE WORLD—MR. JACKSON'S WINTER QUARTERS AT CAPE FLORA.

HONG-KONG.

Hong-Kong is a most interesting place, not only from a diplomatic and a commercial point of view, but also on account of the natural beauties of the situation. It lies south of the peninsula of Cowloon, which belongs to the Chinese province of Kwangtung, excepting the southern point, and that, like the island of Hong-Kong and the water between them, belongs to the English. The island is very mountainous, and the only place it offers for the building of a town is the narrow strip of land along the coast. The mountains extend from east to west, the highest point being Victoria Peak, at the extreme western end. The northwestern flank of this mountain rises abruptly from the sea, but the other side slopes off to the bay, and just there the city of Victoria has been built. The Queen's Road runs from end to end of the city, and parallel to this, on the shore, runs the Praya, on which stand the largest business houses, agencies, hotels, and the market. This fine street will soon be shut in by houses that will be put up on a new wide quay, space for which has been wrested from the sea. From this thoroughfare streets run up about one-third of the height of the mountain, forming a close network of steep and narrow roads, that are generally ascended by means of broad, flat steps. These are inhabited mostly by Chinese, and above them are villas and gardens, the building of the Basler Mission, the Italian cloister, the German and several English churches, while to the east are the Botanical Garden and the station of the cable road. On the central part of the Queen's Road are most of the public buildings, while to the west and east respectively are the sailors' lodging houses and saloons, the hospital and fort, and the barracks and Buddha temples.

Trade is very brisk both in the harbor and the city. Hundreds of jinrikshas—those queer little two-wheeled vehicles drawn by coolies—rush about among the palanquins, each carried by six coolies, one-horse vehicles, equestrians, porters, and other pedestrians; runners, tradesmen, sailors, English soldiers, and small-footed, limping Chinese women with their gayly-dressed children, complete the brilliantly colored picture. Before the bank and post office we see groups of European merchants and here and there the gigantic form of one of the Sepoys who constitute the police force. The Chinese stores, which open on the street, are attractively arranged, especially those of the money changers, where the clicking of the silver dollars is heard unceasingly.

The harbor is no quieter. A long line of ocean steamers reaches to West Point, and near by is the landing for the large saloon steamers for Canton and Macao; many hundred junks (large Chinese sailboats) and sampans (rowboats) move about among the numerous vessels which lie at anchor, and many lines of steamers hurry in every direction, carrying passengers about the harbor and to Cowloon.

Scarcely any one who goes to Hong-Kong fails to visit Victoria Peak, on the highest point of which there is a signal station. The tops of this and the neighboring mountains form an undulating plateau, over which are scattered villas and hotels that are occupied by the Europeans of Hong-Kong when the heat of the city becomes too oppressive. From this height one has a beautiful view of the roofs of the houses in the city, of the moving throngs in the streets and on the harbor, the beautiful blue bay with the numerous vessels, the rocky little islands and Cowloon. Behind the latter rise the mountains of the mainland; on the horizon lie the Ladrone Islands and Lamma; to the east Hotel Bellevue, on a projecting wooded ridge, and behind that the "Happy Valley," where there is a race course, and the cemetery with its fine tombs and decorative gardening inclosed by high walls. This valley is walled in by the high, wooded mountain sides.

In March, when spring reigns supreme, the beautiful terraces on the mountain, with the villas and churches, between which run quiet well-kept streets, are extremely attractive. Everywhere one sees diligent Chinamen busy with the gravel walks and the gardens. It is a delight to pass through the dark wood paths, across ravines and running brooks and through bamboo thickets to the beautiful botanical garden, or Public Garden, as it is called. We publish herewith an engraving of this garden. Here we find the different kinds of palms and conifers and plants of every description most artistically arranged. Above the tops of the oaks rises the blue wall of the peak, the top of which is enveloped in clouds, and among the branches of these trees the sea eagles pass back and forth on their way back to the mountain heights after having secured their prey among the vessels in the harbor,

and the sun shining through the branches strikes the glistening dome of the bank and the everchanging bay. But, while everything here seems to be called into new life, death is reaping its harvest below in the damp Chinese quarter, where the plague has raged for fourteen years past. It is no wonder that disease should take such a hold here, for the people are crowded together in filthy houses of many stories, from which most unhealthy odors come, and even the vermin of the narrow streets serve as nourishment for these men who are dying of uncleanliness, hunger, and opium. The strings of dried ducks, fish, and rats, that decorate the stores, are considered great delicacies by them. But, in spite of poverty, sickness and death, the Chinese amuse themselves, and on the ground floors of the houses on the harbor we find places of amusement decorated with colored lanterns and grotesque statues of Buddha, as well as puppet theaters and many gambling dens. For an entire day a procession moved back and forth through the Chinese quarter with gongs and fifes, priests under baldachins, paper temples, and children who had been painted and dressed in much finery. The object of all this was to send away the plague, but the English took more effective measures, pulling down whole streets where the conditions were worst. When things seem to be improving, however, the disease slips in again on account of the constant traffic between Hong-Kong and Canton. Besides the many small steamers and sailing vessels that come down the river every day, there are the large Hong-Kong sidewheelers that take hundreds of Chinese to and from Canton daily, carrying them between decks. In spite of this, a trip to Canton is one of the pleasantest excursions to be taken from Hong-Kong.—Illustrirte Zeitung.

BOTANICAL GARDEN IN HONG-KONG.

THE DEVELOPMENT OF MICHIGAN ARCHÆOLOGY.*

By HARLAN I. SMITH.

THE prehistoric remains of Michigan are fast disappearing as an inevitable result of the advance of civilization. The plow every year levels and obliterates more completely the earthworks which were once important monuments. Railroads are cut through them, and towns are built over the sites where once a ruder civilization centered. Mounds unfortunately are not left to be gradually reduced by natural agencies; they are dug down often by men working in the name of science, but hunting merely for relics to gratify an unrestrained curiosity, not for facts to be given to the world of students. Such exploration seldom proves of any scientific use. The results are not noted by the excavator, and as a usual thing, only the striking objects are noticed, or preserved, while the more instructive, and hence more valuable, are generally overlooked or discarded. It is evident that such work not only fails to add anything to our knowledge of the archæology of the State, but in reality is destructive of every prehistoric monument with which it has to do. So nature and man, co-operating in the work of destruction, are rendering inaccessible the facts which our prehistoric earthworks have to reveal to the student. It is therefore of the greatest importance that scientific examination be made of all such remains as soon as possible, and that the results of exploration be preserved for future study and comparison. It is from such methods only that we may hope to learn more about the early American race. Now that deeper interest is being exhibited in the work, steps may perhaps be taken to have what still remains in Michigan preserved until surveys and explorations of the localities can be made.

The extension of our knowledge of Michigan archæology will necessarily be gradual. In this State the educational value of anthropological investigation is not yet appreciated by a sufficient number of persons to faciliate securing the funds necessary for the work required. Superficial excavation retards advancement and cannot be tolerated by scientists. The work must be taken up in a systematic manner and carried forward along definite lines. It is clear that the fragmentary data at hand emphasize the necessity of thoroughness and precision.

In the first place, the data already collected should be put into convenient form for use. The same system should be applied also in classifying new data obtained from the field. In this way new material may be added to that at hand, or inserted in its proper place among the established files. All this may be accomplished by the use of a card catalogue. Every publication, manuscript, map, photograph and specimen may be indexed upon a card for alphabetical insertion in such a catalogue. Each subject should be indexed under all the various heads from which it may be approached. It is convenient to name the various remains and always to refer to them under that name.

Again, all earthworks should be indexed geographically as well as by name, and a map constructed locating each in the same manner. Then in envelopes or boxes, arranged alphabetically by these names, may be kept all the data referring to each particular locality. As fresh data are secured they can be inserted in the proper place; eventually all this material may be put in form for publication, having been classified geographically as secured. The names and addresses of individuals interested and willing to assist, or having information of value, may also be inserted in the same card catalogue. Each card should have particulars concerning the person named on it, the range of his interests and knowledge, and such other references as might be considered of value for future use. Such individuals should also be indexed by locality and referred to under the names of subjects upon which they are authorities, and under the particular investigation in which they may be able to assist. This being done, whenever an investigation is carried on in a certain region, the explorer can readily refer to all sources of information and aid. Maps, photographs and photographic negatives, specimens and other similar material may be numbered and by this means reference may be made to them from the cards and in notes and publications.

Finally, every earthwork, village site, workshop, mine and quarry ought to be surveyed, photographed and explored. This would require years of work, but the result would be most satisfactory. Very little has been done in Michigan, and hence the field is open; the facts can be obtained without the confusion or misleading circumstances which the student has to meet in many other localities.

This work may be best carried on with the State university for headquarters, where materials may be worked up for exhibition and kept accessible to students. The university can direct the work better than any other institution, besides caring for collections intrusted to it in the best and most impartial way. And it is for the State's guardian of learning and research to foster such undertakings. Individuals are ready to give privileges for exploration to such an institution, and are often glad of a safe deposit for their records and specimens; an increasing number are coming to realize the importance of placing their collections where they can be of use to many students instead of affording gratification to but one or two.

Valuable data can be secured at a very slight expense by a surface survey, if the parties making such are each headed by a competent director, and made up of students. Students are often willing to devote their time during a summer vacation to such interesting work. Parties could proceed to examine every section in each township, taking the townships in order until a county was covered, and so on throughout the State. Such a party should include men fairly well informed in civil engineering and photography, as well as geology and some of the kindred sciences.

As such a party proceeds it should take careful observations of all works and village sites, make detailed maps of them, and locate them on a large map of the State. Photographs should be taken of all features which can be well shown and recorded by that method. Specimens should be collected from the surface, and deposits and gifts should be invited from persons interested in the survey. Individuals everywhere will be found willing to furnish recorded data or oral descriptions.

By making the fact known that the university is ready to receive material and hold it in trust, much may be directed to a safe deposit in the museum. The privilege of reserving earthworks for exploration by the university may be obtained, and it should be urged that all discoveries be reported to the officers in charge.

* Presented at the first meeting of the Michigan Academy of Science.—Reprinted from the Inlander.

All assistance, records and specimens received in the ways mentioned should be at once suitably acknowledged and carefully recorded. This is a very important matter to take up soon, with the purpose of constructing a complete archæological map. The results of the surface survey should be indicated upon the map and supplemented by notes arranged so that they will be subject to ready reference from it. Much may be known from a surface examination without excavation; a very little excavation entails more expense than a complete surface survey.

The surface survey being completed, it would be a comparatively easy matter to keep track of the progress of roads and other agencies which destroy such remains, so that they could be explored as danger approaches them. It would be well to interest students in all parts of the State, so that they may give notice when any cause of destruction threatens antiquities; such remains may then be examined before lost. The few liable to immediate destruction could be excavated at a comparatively small cost, while those unmolested and protected by timber or even small vegetation could be explored at convenience or left for students in the future.

Preliminary notes on a scheme of this kind are seldom expected to cover every point, or to be complete in detail. No scheme, to the writer's knowledge, exists for the study of the archæological material in the State. These notes are offered simply as preliminary suggestions which may be followed until a more extensive plan can be carried out, with the expectation that if they are put into execution, they will be modified and improved as developments warrant.

A CAPTURE OF ELEPHANTS IN SIAM.

It is in one of those numerous islands formed by the capricious windings of the Menam, not far from the ruins of Ajuthia, the old capital, that is to take place the great capture announced many months ago and awaited with impatience by the Siamese. It takes place, in fact, only at rare intervals (every five or ten years), either when the king wishes to offer this curious spectacle to some guest of distinction, or when he has need of restocking the royal stables for his personal use or for some princely present. The population, from 18 to 25 miles round about, makes great preparations for these festivities, which are to last several days.

For a month already the drove of domestic elephants has been seen making its way toward the north. Guided by the chief of the elephant drivers, it is proceeding by short stages to the province of Nakou-Naiok, where, according to the season, the wild elephants are stationed, now in the immense plains covered with reeds and high grass and now on the wooded declivities of the mountains of the same name. Having reached this region, the thirty or forty domestic elephants are skillfully arranged as skirmishers, and after executing several flanking movements, succeed in collecting together a true herd of nearly two hundred animals, which, like the sheep of Panurge, allow themselves to be docilely led behind a row of domestic elephants.

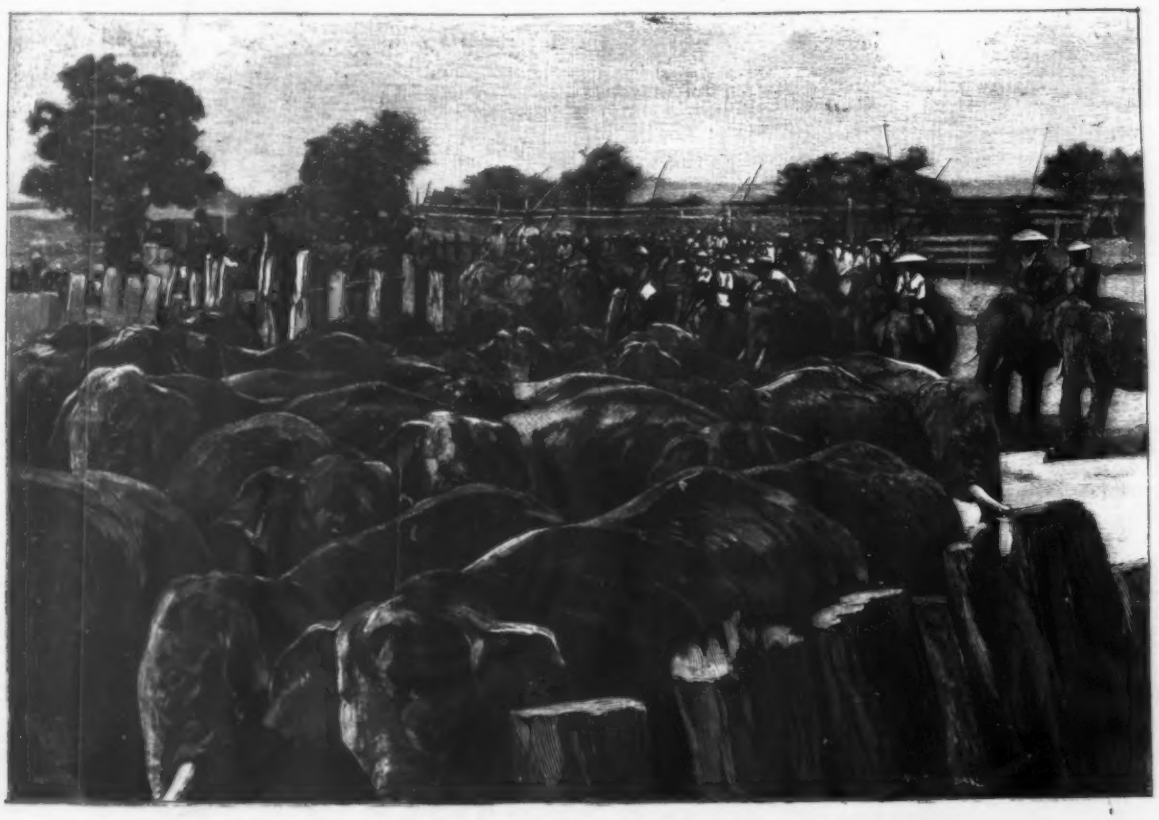
Then, altogether, and very slowly, they take the road for Ajuthia; and it is no small affair to traverse these regions with this moving mass. It is necessary to take circuitous routes and to keep as far away as possible from cultivated fields and from habitations, for the aspect of a country traversed by such a herd may be easily imagined.

Finally, they are not more than twenty-four hours from Ajuthia. The rumor quickly spreads through the country, and the authorities are forewarned. The day of the capture is fixed.

From early morning the river is plowed by boats of the most varied kinds, from the little sampan maneuvered with the paddle up to the steam launches that tow the more spacious junks and the picnic boats of the Europeans that have come from Bangkok. Immediately after disembarking, the crowd wends its way toward the kraal where the exciting spectacle is to be exhibited. This is a vast inclosure of about 4,300 square feet, formed of a wall 10 feet in height and 6 feet in width, and constituting a spacious promenade, from the top of which the spectators can view everything without any danger.

Two wide openings are formed in this thick wall for

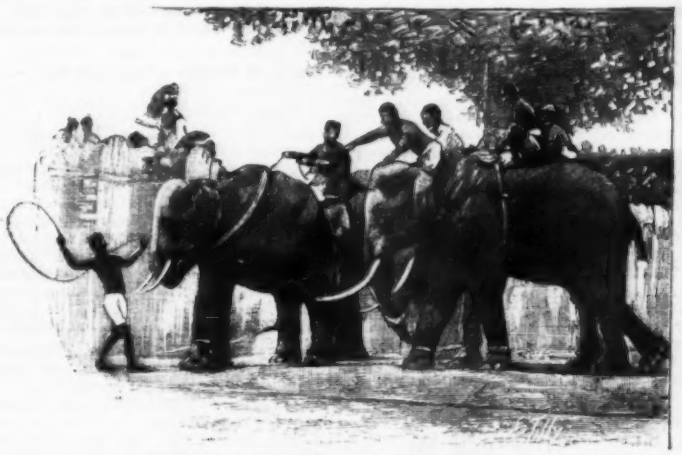
THE FIRST FETTERS.



A CAPTURE OF ELEPHANTS IN SIAM—AT THE GATE OF THE KRAAL.

the passage of the elephants. One of these is in the center of one of the sides and the other in an angle of the opposite side. At ten feet from the interior wall of this first inclosure there is an immense stockade formed of large stakes driven deeply into the ground and connected at a height of 6 feet by a transverse beam, which is itself strengthened here and there by other stakes forming stanchions. At the exterior of the inclosure this row of stakes is continued and forms an obtuse angle, whose summit touches the central gate and the extremity of whose sides reaches the river that the elephants are to cross. The latter are announced for nine o'clock in the morning; so the crowd does not leave the ramparts from which it hopes to soon view the spectacle. But the elephants have not learned in domesticity to be as punctual as their royal masters.

After many false alarms upon the opposite bank, the dark foliage of the bamboos is seen to stir on the horizon. The silhouette of an elephant ridden by two drivers is observed, and then a second and a third, and finally the mass of wild elephants in a thick cloud of dust. There is no longer any doubt of it; it is they—



BREAKING IN A WILD ELEPHANT.

they are coming, they are approaching. See the scouts upon the opposite bank! They are entering the river, followed at a few yards behind by the entire herd. It is for every one then to run with all haste and seek a good place to see the entry, which is assuredly one of the most stirring peripetia of the hunt. The wild elephants follow their tamed brothers like a flock of sheep, and with them unhesitatingly enter that narrow passage at the end of which there will, perhaps, be future slavery.

Since the passage becomes narrower as they approach the fatal entrance, they can neither turn nor retrace their steps, but must move ahead, even though they do not want to. And they pass only one by one. If, by chance, two are caught in this narrow passage, terrible collisions occur, and one might think that he heard their bones crush, until the driver, armed with a long iron hook, intervenes in order to make the weaker of the two elephants give way under the influence of pain. From the top of the promenade nothing is any longer seen but an undulation of monstrous spines. But the evening approaches, and they are to be left alone in this great quadrangle to pass the night deprived of food and drink, in order to further tire them and to make it possible to more easily seize upon those that will be selected upon the morrow.

Upon the dawn of the second day we meet only with groups of elephants ridden by their drivers. They are going to the river to bathe. Immediately afterward they are harnessed for the combat. This is certainly neither a lengthy nor a complicated operation. A buffalo leather strap firmly attached around their body at the height of the withers, and they are ready. They then enter the arena, each directed by two drivers. One of these, astride of the head, holds in his hands a bamboo around which is wound a rope terminating in a slip noose. The other, squatting upon the back, directs the animal. Having entered the interior, they push before them the wild elephants which take flight. It is at this moment that, upon the order and designation of the chief, the driver sitting upon the head approaches the animal selected. At the moment at which the latter, in its flight, raises a hind leg, the driver seizes it with the slip noose, and then quickly moves away in order to allow of the unwinding of the fifteen or twenty yards of rope, which trails along the ground.

The animal thus attached continues its travel with the rest of the herd, but soon feels itself arrested. The men who are watching the hunt from behind the stakes observe the moment at which the extremity of the rope is within their reach, seize it upon its passage, and fix it firmly to one of the stakes.

After a half score of animals have thus been selected, the entire herd is marched out of the kraal and led to the nearest arm of the river, where it is held by a line of domestic elephants.

The last act of the hunt begins at this moment. The prisoners are allowed to exhaust themselves for a few instants in vain efforts to free themselves from their trammels; and then, after they have become slightly calmed, the individual capture is proceeded with. To this effect, three of their tamed brothers approach each one of them (one to the right, one to the left, and one behind) as he attempts to run. It is a question of leading him out of the kraal, and for this purpose to keep him between his two companions by means of a collar passed around his neck and firmly connected with the belly band of his neighbors. This operation finished, the rope that attaches him to one of the stakes of the kraal is unfastened and the captive is led to the exterior to the foot of a post placed in a vast shed, where he will thereafter have to live under the surveillance of a driver whose business is to take care of him, feed him, and train him. The hunt finished, the herd of elephants is led to the country of its origin and set at liberty.—L'Illustration.

NEPTUNE'S JUBILEE YEAR.*

By Sir ROBERT BALL.

IN the course of the present year we have to celebrate the fiftieth anniversary of one of the most famous astronomical discoveries of modern times; indeed, it may truly be said, of one of the most famous discoveries ever made in the whole annals of astronomy. There is no chapter in the history of science which contains incidents of a more dramatic character than those which are described in the narrative of the discovery of the planet Neptune. Nor are other associations wanting to lend additional attraction to this splendid achievement. The human element, without which no story could be completely interesting, is here also present, and a memorable controversy, the smouldering embers of which still occasionally burst into flame, has arisen with respect to the discoverer of the remotest planet in our system. At the present time, when the lapse of just half a century has again stimulated a general interest in the subject, there seems to be a special propriety in attempting once more to draw attention to the series of never-to-be-forgotten investigations which brought Neptune into light.

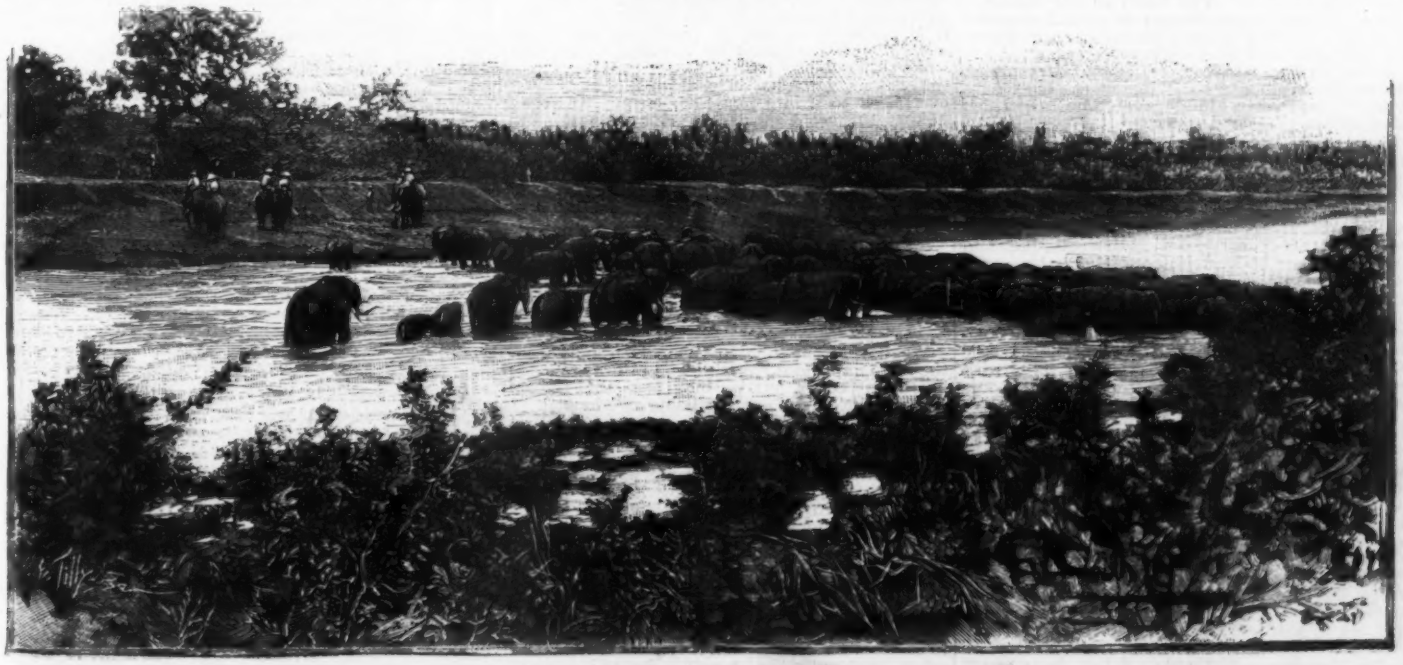
To tell the story from the beginning, it is necessary to commence with the latter part of the last century, when those who loved to hear about the stars were astonished by the announcement of the first discovery of a planet which had ever been made since the time when history commenced. The older planets, Jupiter, Saturn, Mercury, Venus, and Mars, had been known to observers of the heavens prior to the very earliest ages of which we have any record. No fresh additions had been made to the slender list of five until William Herschel, then organist at the Octagon chapel, at Bath, suddenly sprang into fame by the announcement that with a home-made telescope, on the night of March 13, 1781, he had discovered the vast orb which presently received the name of Uranus.

Herschel was led to this discovery by having imposed upon himself the task of examining all the stars he could find whose magnitude exceeded a certain limit. In the fulfillment of this scheme he happened on the night in question to be reviewing the various stars in the constellation of Gemini, when his penetrating glance was attracted by an object which seemed different from the ordinary stars which are strewn in such thousands over the sky. Closer inspection revealed that this object was a planet. Hence came the announcement of the superb discovery of a mighty orb which revolved far outside the orbit of Saturn. An immense enlargement was thus given to the dimensions of the planetary system as they had been previously understood.

When Herschel had directed attention to this new object Uranus, it was naturally submitted to careful observation by astronomers all over the world. They were anxious to learn all that they could with reference to the nature and the movements of this newly added member of our solar system. It was presently found that the planet required a period of about eighty-one years for the accomplishment of a complete revolution around the sun. As the years passed by, observations were accumulated showing the several points which the planet occupied in the different stages of its circuit. More and more accuracy was thus infused into our knowledge of the various circumstances of the motion of Uranus. At last astronomers were able to follow with all needful precision the mighty highway which the great planet pursued as it traced out what was then supposed to constitute the frontier of the solar system. It was found that, like the orbits of all the other great planets, the highway of Uranus was not exactly a circle; it was, in fact, an oval, or, as we should say more accurately, an ellipse, and the details of the size and position of this ellipse were carefully studied and became exactly known.

As soon as the track of Uranus through the heavens had become determined, it was possible to find with some approximation the position which the planet occupied at any particular date, even though that date were antecedent to its discovery. In fact, a time table was formed from which the locality of the planet, not only for each year, but even for each day, could be ascertained for any past epoch, extending, if necessary, to centuries before Herschel lived. It happens, singularly enough, that a planet of the size of Uranus, and situated at its distance from the earth, bears a striking resemblance, though of a very superficial kind, to an ordinary star. Such a planet is indeed very liable to be mistaken for a star, and as the history of Uranus was studied it came to the knowledge of astronomers that though this object had never been recognized as a planet before the eagle glance of Herschel first detected it, yet that it had in a certain sense often come under the observation of preceding observers. Nor is this fact to be wondered at when we reflect that Uranus is bright enough to be visible with the most moderate telescopic power. These earlier astronomers, who, in the course of reconnoitering the heavens, happened to light on Uranus, not unnaturally took for granted that it was a fixed star; it never occurred to them that it was anything essentially different from one of the thousands of similar looking objects lying all around. They never imagined that it called for any further recognition than was implied by noting its magnitude and the ex-

* From the New York Sun.



HERD OF ELEPHANTS BATHING.

act position which it occupied in the sky. These early observations in which the planet was mistaken for a star, and had its places recorded in catalogues with thousands of undoubted stars, have since proved to be of signal service in connection with the immortal discovery which we are presently to set forth. Little could any one of those ancient astronomers have suspected that, while his attention was fixed on a supposed star whose place he was so carefully measuring, he was just on the very brink of a discovery which would have rendered his name famous throughout the ages.

The records which these astronomers have left possess, however, great importance for our present purpose, because we are able by their aid to learn the track along which the planet was moving during the century which preceded its discovery. Thus the study of these early investigations permits us to learn the exact position occupied by Uranus years before attention had been directed to it by the achievement of Herschel.

If a planet were permitted to pursue its movements without interference of any external forces, so that it was guided solely by the supreme central attraction of the sun, then the orbit of the planet would be invariable. Each revolution would be performed along the same ellipse precisely as that which was traversed during the preceding revolution. When the highway which Uranus was following at the time of its discovery and for years subsequent thereto was compared with the track which the same planet was pursuing in those earlier years before Herschel's time, when it was unwittingly observed by preceding astronomers, it was found that the two tracks did not agree. No doubt the differences were but small between the actual position in which Uranus was found by the early observers and the positions which calculations based on the latter observations would have assigned to the planet. But they were quite large enough to be unmistakable when we remember how accurately the determinations of positions can be effected in our observatories. It was therefore clear that there must be some other influence upon the planet Uranus besides that which was due to the supreme controlling attraction of the sun. Astronomers had been long accustomed to find that the movement of the planets varied from the movements which those planets would have had if the sun's attraction had been the sole guiding force. In all such cases it had been the custom to seek for an explanation of the observed discrepancies in the effects produced by the attraction of the outer planets.

It was known, for instance, that the movements of the earth were in this way affected by Jupiter, and that the movements of Mars were affected by the attraction of the earth. In fact, every one of the planets exercises a disturbing effect on the movements of each of the other planets, the amount of those disturbances depending primarily upon the mass of the disturbing planet, and also, of course, on the other circumstances of the movements of each of the bodies. The studies of mathematicians have so far perfected our methods of calculating the effects of these forces that we are able to determine how much each planet is forced to swerve from its track in virtue of the pull exercised upon it by every other planet. Generally speaking, the disturbances which observation showed to take place in the movements of the heavenly bodies admitted of being completely accounted for as consequences of such attractions. Thus, for instance, in the case of two mighty neighboring planets, Jupiter and Saturn, there was an irregularity in the movement of Jupiter which was most satisfactorily explained to be a consequence of the attraction of the planet Saturn, and a corresponding irregularity in the movement of Saturn was satisfactorily attributed to the disturbing effect of Jupiter.

When it appeared that Uranus was performing movements which indicated that the planet was affected by certain perturbations, attempts were naturally made to account for those perturbations by showing that they were the consequences of the attractive power of the other bodies in the solar system. The effects which Jupiter could produce upon Uranus admitted of being estimated, and so, also, the disturbing influence of Saturn as well as of the other planets could be ascertained.

After due allowance had been made for all known source of disturbance, it was, however, found that there were still certain discrepancies outstanding between the places actually occupied by the planet discovered by Herschel and the places in which calculation seemed to locate it. The belief in the universal validity of the laws of gravitation is so well founded that it suggested the possibility that the perturbations of Uranus, which could not be otherwise accounted for, must be due to the attraction of some other planet which was quite unknown to astronomers. This gave rise to one of the grandest intellectual problems which the mind of man has ever solved.

(To be continued.)

COMMERCIAL AND INDUSTRIAL PROGRESS IN JAPAN.

From returns which have been published in Japan of the trade of the country for the two years, 1889 and 1895, we can gather at least an approximate idea, says London Engineering, of the trend of progress in the country. The following figures are from the customs returns for the two years mentioned.

These figures, so far as they go, prove that the commercial relations of Japan with neighboring Asiatic countries show a far greater advance than those with western countries, the relative ratio of the increments being for the exports, with Asiatic countries 263 per cent., with western countries 71 per cent., and for imports 193 per cent. with Asiatic countries and 82 per cent. with western countries. If we attempt to analyze the returns, we have some interesting results, as is shown in the following table.

The figures demonstrate the important fact that while the increases in Japan's export trade to China and other Asiatic countries are mostly in manufactured articles, the imports from those countries consist chiefly of raw materials. With the West, exports show a marked increase in silk, habutaye (a kind of white silk fabric) and matting, while the chief increments in imports are in shirtings, railway materials and steamers. The development of the match manufacture in Japan has been most remarkable. A few years ago it was non-existent, but now, not only do the Japanese

Exports.

—	1889.	1895.	Rate of Progress.
	yen	yen	per cent.
United States of America	25,292,873	54,028,950	117
England	7,661,599	7,383,091	10
France	14,348,727	21,006,956	54
Germany	1,638,333	3,340,012	103
British India	1,311,153	4,159,236	225
China	5,442,507	9,135,109	67
Hong Kong	7,337,896	18,382,802	150
Korea	1,092,203	3,831,470	250
Philippines	23,625	194,831	725
Australia	436,579	1,231,103	182

Imports.

United States of America	6,143,171	9,276,389	51
England	26,067,035	45,172,110	73
France	3,334,168	5,180,134	53
Germany	4,897,900	12,233,154	150
British India	7,333,859	19,001,810	63
China	9,190,698	22,935,144	150
Hong-Kong	4,103,703	8,076,189	96
Korea	1,373,331	2,925,590	130
Philippines	217,496	1,220,744	437
Australia	267,095	1,081,725	286

manufacture the matches required for their own use, but they have also obtained a practical monopoly in the far East with that article. Cheap umbrellas of Japanese manufacture are also now to be found in every market in the East. The development of the cotton industry, of which we have from time to time given details, has been very great, and only seems to be limited by the supply of raw cotton and of labor. The former difficulty will be overcome as shipping facilities are increased, but the latter is likely to increase, and the increase of wages will, to a certain extent, neutralize the present advantages of the Japanese. According to the latest returns of the Cotton Spinners' Union, the total number of mills in the Union is 67, with 607,505 upright spindles, 86,404 slanting spindles, and an addition of 453,136 spindles to be put in operation before long, an aggregate of 1,147,045. The horse power in operation is stated to be 15,595, and the average consumption of coal per horse power being 3·498 lb. per hour. It will no doubt interest some of our readers to know that the wages of male

Exports.

—	—	1890.	1895.
		yen	yen
Hong Kong	Twilled cotton fabrics	6,980	184,973
	Matches	1,150,481	2,422,015
	Silk handkerchiefs	80,380	221,796
China	Cotton cloth and yarns	632	683 087
	Cotton flannel	1,582	140,275
	Umbrellas	102,745	342,715
	Matches	231,247	1,266,892
Korea	Liquors	39,380	748
	Cotton cloth and yarns	192,697	243,578
British India	Matches	27,346	802,783
	Silk goods	9,180	134,212
Canada	Tea	837,598	1,311,718
United States of America	Tea	5,157,691	7,121,356
	Silk	9,237,659	27,826,244
	Habutaye	245,114	1,361,899
	Matting	290,564	3,083,122
France	Silk	9,237,659	27,826,244
	Habutaye	464,833	1,677,123

Imports.

China	Beans	512,997	1,380,265
	Ginned cotton	2,655,466	13,786,101
India	" "	1,114,284	7,693,224
Korea	Hides	173,061	517,730
England	Cotton shirtings	1,716,981	3,065,164
	" satins	229,210	776,939
	Rails, &c.	659,435	1,048,608
	Pig iron	80,172	645,455
	Steamers	616,422	3,493,423
Germany	Nails	355,945	1,065,844
France	Wines	96,140	220,883

operatives run from 15 to 26 sen a day, giving an average of about 19 sen, while those of female operatives are from 7 sen to 17 sen, or an average of about 11 sen (a sen is equal to one-hundredth of a yen, which latter, again, at present is equal to a little over 2s. 2d.). The total number of power looms is given at 3,095.

From the latest report of the Tokio Woolen Fabrics Company, it seems that after a period of considerable difficulty, caused chiefly by the want of experience of the workers, the company is now in a flourishing condition, and paid 12 per cent. as its last dividend. The fact that the company is now producing cheaper classes of goods, which are within the resources of the working classes, has caused a great demand for them. The government has also a woolen factory near Tokio, but it is employed entirely in producing one or two descriptions of goods used by the troops, and, therefore, is not of much use as a place for training workers for the ordinary markets. The difficulties have now, however, been to a large extent overcome, and the Tokio factory turns out goods of such excellence as to bear comparison with the produce of foreign looms.

From a return which has been published of the amount of capital involved in enterprises projected or initiated from January, 1895, to the end of May, 1896, a period of 17 months, we extract the following figures:

	Yen.
Railways	378,980,000
Banks	114,435,000
Industrial works	206,811,500
Total	700,226,790

We have, from time to time, given some account of the more important shipping and railway undertakings in Japan proper, but we may note that the outlying parts of the empire are not being overlooked. In the northern island, or Hokkaido, a company with a very ambitious programme has been projected. The Hokkaido Colliery Railway Company contemplates the augmentation of its capital from 8 million to 28 million yen, with the view of shipping its coal direct. This will not only involve the extension of its railway and mining operations, but also the purchase of a fleet of twenty steamers of 5,000 tons displacement each. Probably, however, a less ambitious programme will be found sufficient for a considerable time. Moreover, it is stated that some leading merchants in Tokio and Osaka are organizing a railway scheme for Formosa with a capital of 8 million yen. The projected line is to extend from Hiang-shan to Takao, a distance of 190 miles. Evidently the boom in industrial enterprises in Japan is by no means exhausted.

SELECTED FORMULÆ.

Spruce Beer.—(Mineral Water Review.)—

Hops	2 oz.
Sassafras	2 "
Water	10 gal.

Boil half an hour and then add

Brown sugar	7 pd.
Essence of spruce	1 oz.
Essence of ginger	1 "
Pimento	1½ "

Put the whole in a cask and let cool; then add ½ pint of yeast; let stand for 24 hours, fine and bottle.

Spruce Beer.—(Harrop's Monograph.)—

Essence of spruce	4 fl. oz.
Sugar, granulated	10 pd.
Water, boiling	10 gal.
Yeast	8 fl. oz.

Mix the above ingredients, excepting the yeast, place in a covered vessel until cool, stirring occasionally; when lukewarm, add the yeast and keep in a warm place; after fermenting one day, strain through flannel, let stand a short time, remove the scum and bottle.

Mead of Meth.—(Cesky Lloyd.)—

Honey	10 liters.
Water, distilled	40 "

Put into a caldron and boil together for 1½ hours, removing the scum. When cool, fill a cask up to the bung hole, and let it remain open in a cellar of medium temperature. As soon as fermentation, which begins in about one week and is finished in two, is over, draw the contents in another cask, carefully avoiding all yeast. Allow to ferment a second time, after which the mead is drawn into bottles. To give an agreeable flavor, a little honey is put into the cask, and if the fermentation is to be quicker, some yeast to start fermentation is added. The longer the mead remains in the cask, the better and the finer the flavor.

Quince Cider.—Take a quantity of ripe quinces, cut into quarters, and with the pips, etc., removed. Boil these in a copper with double their weight of water; when boiled to perfect softness pour the must into a vat. To this add, for every 50 pints of must, 2 pounds of sugar and ½ pound of yeast, diluted in a sufficiency of hot water. Mix the whole well together, and allow to ferment. Then strain and bottle.

Orange Cider.—(American Carbonator.)—A cider could probably be prepared by expressing the juice of sweet oranges, first crushed and allowed to macerate overnight, adding an equal quantity of water and one pound of sugar or glucose for each gallon of juice (or 2 gallons of diluted liquid), allowing it to stand in a vessel covered so as to exclude the air, but with an opening to allow the escape of carbonic acid gas formed during the fermentation. The mixture should be kept at a moderately warm temperature (80–90° F.) until the fermentation is completed, when the clear liquid should be drawn off and preserved in tightly stoppered vessels.

A new test for sugar in the urine, devised by Dr. A. R. Elliott, and claimed to be most accurate, is as follows:

Solution One:

Cupric sulphate	27 grains.
Glycerine (pure)	3 drachms.
Distilled water	2½ "
Liquor potassæ, ad	4 ounces.

Dissolve the cupric sulphate in the glycerine and water, and gently heat. When cold, add the liquor potassæ.

Solution Two.—A saturated solution of chemically pure tartaric acid. These solutions are quite stable, and keep indefinitely. Into a test tube pour a drachm of the cupric acid solution. Boil gently over a spirit lamp. Then add two or three drops of the tartaric acid solution, and boil again. The urine is now added slowly, drop by drop, until eight drops are added. If no reaction takes place by this time, there is no sugar. The reaction is a yellowish or reddish or greenish gray deposit of suboxide, which is marked and unmistakable. In a few minutes, the reaction deepens.

Clam Bouillon.—

Extract clam bouillon, about	2 tablespoonfuls.
Prepared milk	1 dessertspoonful.
Extract aromatic soup herbs	5 drops.
Extract celery and pepper	5 "

Hot soda sufficient to fill cup.

Montpellier Cough Drops.—

Brown sugar	10 pounds.
Tartaric acid	2 ounces.
Cream of tartar	12 drachms.
Water	3 pints.
Aniseed flavoring, sufficient quantity.	

Melt the sugar in the water, and when at a sharp boil add the cream of tartar. Cover the pan for five minutes. Remove the lid, and let the sugar boil up to crack degree. Turn out the batch on an oiled slab, and when cool enough to handle mould in the acid and flavoring. Pass it through the acid drop rollers, and when the drops are chipped up, and before sifting, rub some icing with them.—Confectioners' Union.

Patent Leather Varnish.—

A varnish that will not peel off or crack from the leather is a desideratum, and one that should sell through chemists, and bear a good profit. Such a one is, according to the Trade Recorder, to be made from the following formula:

Resin (black)	7½ oz.
Venice turpentine	7½ "
Oil of turpentine	7½ "
Sandarac	15 "
Shellac	1 lb. 14 oz.
Alcohol	11¼ pints.
Lampblack	4 oz.

Digest the resin, turpentine, sandarac, shellac, and alcohol together, afterward add the lampblack, and well mix. Apply with a soft brush.—Magazine of Pharmacy.

ENGINEERING NOTES.

The Congo State Railway has reached Kimpesse, where the caravans for Stanley Pool recruit fresh carriers.

The Paris and Lyons Railway terminus in Paris is to be rebuilt, at an estimated cost of $3,600,000. The work has just been begun. It will last ten years.

Ostend is to have a new system of docks, extending a couple of miles inland and including dry docks, on which $15,000,000 will be spent. The money is contributed partly by the town and partly by the Belgian government.

As the guards fitted under water to the after part of the hull of the torpedo destroyer Rocket to protect the propellers have been found not to affect her speed materially, all vessels of that class will be provided with similar guards.

High explosive shells have proved so successful with quick firing breech loaders in the French experiments, that the British Admiralty has already supplied the Channel fleet with them, and will soon provide shells for the whole navy.

The friction of the 5,000 horse power turbines at Niagara is so small that when once started they will run light with a gate opening of one-sixteenth of an inch only. Careful experiments have shown the wheels to have an efficiency of 80 per cent., which is 5 per cent. in excess of the guarantee.

Germany has made some bold experiments at railroad speed on the line between Berlin and Görlitz. The best performance was 65⅝ miles, which was 12 miles better than the highest speed of the fastest German train, the Berlin-Hamburg lightning express, which does 177½ miles in 3½ hours. Ordinary German express trains make 48½ miles an hour.

Piles from 100 to 105 ft. long are being used by the Tacoma Land Company, of Tacoma, Wash., in replacing a portion of its sea wall with a pile and stringer wharf. The water is 30 ft. deep and the outer row of piles range from 100 to 105 ft. in length, 10 in. diameter at the tip and 22 in. at the butt. The piles are made from the "Washington fir" (the Douglass pine), and from the same timber a few piles were cut and recently used, 120 ft. long and 24 in. at the butt. Sticks 90 ft. long, three car lengths, in squared timber are often shipped east; and it is expected that changes in the alignment of the railway will soon permit the shipping of 100 ft. lengths.

The results of some valuable experiments on the lubrication of machinery bearings have been set forth by Mr. Dewrance, in an address before the Civil Engineers' Institute, London. His observations show that olive oil becomes black and thick after passing through the bearings several times; this oil, after filtration, was composed of 16 per cent. of oleate of lead, 9·57 per cent. of oleic acid, and 74·62 per cent. of olive oil and glycerine—the oleic acid in the olive oil appearing to attack lead, zinc, and copper with great activity; thus disks of metals used in the manufacture of bearings were immersed in oleic acid, occasionally drawn up out of the acid so as to be exposed to the air; lead and zinc rapidly corroded away, copper was corroded to a less extent, while tin and antimony were not appreciably affected. In regard to the compressibility of alloys, it is suggested by this authority that no alloy be used until it is satisfactorily demonstrated that its point of first yield is considerably above the greatest load or shock to which it will be subjected in use. In testing the effect upon soft metal bearings when the shaft sustained a heavy pressure, a piece of iron was found to leave no mark upon a surface softer than itself.

Within a few months, unless some hitch occurs, will be begun the construction of the first railroad that has ever been built in Corea, says the Railway Review. It is to run from Seoul, the capital, to its seaport, Chemulpo, a distance of about twenty-five miles. The concession under which the railroad is to be built and operated was granted to an American citizen, and the road will be constructed with American capital and under the supervision of American engineers. The president of the construction company was one of the first foreigners to enter the country, when it was first opened in 1882, and has spent a number of years there. He is on terms of personal acquaintance with the king, and about a year ago he had the contract of placing an electric light plant in the sovereign's palace. He has recently obtained a concession for the working of several gold mines in the interior, and has sent for engineers from this country to develop them. Under the terms of the concession the construction of the railroad must be begun before March 29 next, and the road must be completed within two years from that time, unless prevented by the existence in the country of a state of war or other unavoidable disturbance.

A blue book has just been published giving the returns of accidents and casualties reported to the Board of Trade as having occurred upon the railways in the United Kingdom during the twelve months ended December 31, 1895, says the Practical Engineer. In the lists of both killed and wounded there is a decrease since the record of last year. The total number of killed was 1,424, a decrease of 91, and of injured 4,021, a decrease of 99 on the year 1894. The numbers are classified as follows: Passengers killed from accidents to trains, rolling stock, permanent way, etc., 5; injured, 399; by accidents from other causes—killed, 78; injured, 710. In 1894, 117 passengers were killed and 1,168 injured. These figures show a decrease of 34 passengers killed and a decrease of 59 injured on the preceding year. Turning to servants of railways or contractors, we find that 12 were killed and 88 injured by accidents to trains, rolling stock, permanent way, etc., and 430 killed and 2,566 injured by accidents from other causes. Of persons passing over railways at level crossings, 65 were killed and 33 injured; trespassers (including suicides), 381 killed and 144 injured; other persons not included in the above classification, 53 killed and 81 injured. If all the accidents occurring on railway premises, in addition to those caused by the movement of railway vehicles, be reckoned, it will be found that the total number of personal accidents reported to the Board of Trade during the year amounted to 1,090 persons killed and 9,318 injured.

ELECTRICAL NOTES.

In the new Hotel Cecil, London, there is a telephone in every room.

It is suggested by Mr. Perren Maycock that the wear and tear brought about at contact surfaces by arcing and sparking be called "spark wear."

A reader of the Electric Engineer recently tried the experiment of tying up a sixteen candle power (57 volt) lamp. In twenty-two minutes the towel began to scorch and in thirty-one minutes the lamp exploded and the towel ignited.

An exchange records a good instance of hard work performed by an electric railway motor. A Madison City motor car, equipped with a G. E. 800 motor, was considerably overloaded. Connected to it were four trailer cars, containing not less than 500 persons, and a speed of seven miles an hour was maintained, the motor, car and train running up the heaviest gradients without difficulty.

The Westinghouse Electric and Manufacturing Company has received an order from the Carnegie Steel Company, Limited, for a complete electrical equipment for the Duquesne Steel Works. The new equipment will furnish power for all light cranes, and it is expected that electricity will be employed also in driving the rolls. There will be sixteen large dynamos at the start, and the installation will be made with a view to adding other dynamos.

The Dutch government has decided to operate the large locks at Ymuiden, the outer port of Amsterdam, by electricity, and has placed the contract for the supply and erection, with the necessary plant, with Messrs. Shuckert & Co., of Nuremberg, Germany. The lock is the largest in Europe, and measures 656 feet in length, breadth 82 feet, and depth 52 feet. It is stated that, altogether, 36 electromotors will be required, ranging from 17 up to 45 horse power each.

According to an electrical contemporary, a plan is on foot to establish a regular service of electric tugs on the river Spree, at Berlin. The idea is to set up along the 7½ miles of river which passes through the capital a trolley line supplying current to electric tugs. The present charge for towing the distance is thirty shillings, but it is estimated that by the aid of electricity this charge will be reduced to one-half. The plan has been well worked out, and Messrs. Siemens & Halske are reported to be contemplating putting the idea into practice.

Damage by lightning is unmistakably increasing, according to the director of the statistical office of Berlin. Various causes are assigned, such as the employment of electricity in various industries, the continual change of form of the earth's surface by deforestation, drainage, etc., and the impurities introduced into the atmosphere by the growing consumption of coal. Prof. Von Bezold some time ago showed that for Bavaria the fires due to lightning increased from a yearly average of 32 in 1833 to 1843 to 132 in 1880 to 1882, while the number of persons struck by lightning and of those killed rose from 134 and 73 respectively in 1855 to 186 and 161 in 1885. An interesting fact noted is that persons struck generally perceive neither lightning nor thunder, but receive the impression of being enveloped by fire.

The Philadelphia Stockholder, commenting on the news that in London American street railway securities are rapidly growing in favor, says: "Properly built, honestly capitalized, and capably managed, street railways, if located in stable traffic territory, are entitled to the most favorable consideration by investors both here and abroad. Cost of operation is the vital thing. With the initial introduction of the trolley, operating cost was comparatively nominal, but with the lapse of time it assumed proportions, by reason of the growth of repair account, tending to largely minimize net results. Street railway managers, however, are becoming more expert with the accumulation of experience, and the percentage of operating expenses to gross earnings is being kept down to the lowest point consistent with the maintenance of the property. On the whole, they make a very good showing, and foreign money, if judiciously put into street railways in this country, will find remunerative employment."

For some time the cantonal authorities of Bâle have been considering the question of supplying current on a large scale for light and power purposes to the town of Bâle, and to this end have investigated the possibilities of the Rhine, running close by. These investigations have now been completed, says the Western Electrician, and as a result the authorities have resolved to proceed at once with the building of an electric generating station. The Rhine will be tapped at Augst, about three miles from Bâle, and a channel about three-quarters of a mile long will carry the water to the turbine house. At first 7,700 cubic feet of water per second will be available, representing about 9,000 horse power: but should necessity arise, a dam could be built into the river, and the capacity increased. The generators, consisting of direct connected turbines and alternators on vertical shafts, will be arranged in two groups. A voltage of 2,000 volts will be used. At Birsfelden a storage pond, nearly 20 acres in extent and 8·5 feet deep, will be built.

M. Righi, of Bologna, says the Revue Scientifique, has succeeded in reproducing artificially the globular form of lightning whose reality has been so much doubted by physicists. Not only has he succeeded in producing this form of lightning with a movement so slow that the luminous mass can be followed with the eyes, but he has been able to keep the mass at rest for a long enough time to take a photograph of it. M. Righi has obtained the best results by using a powerful Holtz machine with four plates, run by a hydraulic motor and charging a Leyden jar battery of a capacity of 0·75 microfarad. The conditions that are indispensable to the production of this phenomenon are the following: 1. The circuit of discharge must have great resistance. To this end a column of distilled water is introduced into the circuit. 2. The condenser must have great capacity, for the larger the capacity, the slower is the motion. 3. The gas in which the discharge takes place must be properly rarefied, this rarefaction resulting in augmenting the dimensions of the flame as well as the length of its path.

MISCELLANEOUS NOTES.

The Hospice on the Great St. Bernard can now be reached by carriage, the Swiss side of the road having been completed.

Argentina means to get ahead of the European powers in taking possession of the South Shetland Islands on the edge of the Antarctic continent. An expedition will be sent out for the purpose in December next. The islands may possibly be of some use as a sealing and whaling station.

An analysis of two thousand accident policies on which benefits were paid shows 531 persons injured by falls on pavements, 243 by carriages or wagons, 75 by horse kicks or bites and 47 by horseback riding; 117 were cut with edge tools or glass, 96 were hurt by having weights fall on them, and 76 were hurt in bicycle accidents, while 72 were hurt by falling down stairs.

Two French newspaper men, who started without a cent from Paris a year and a half ago to go around the world, earning their way by disposing of articles and pictures to the newspapers of the towns they visit, have got as far as Hong-Kong. From time to time they print a paper called En Route, got up entirely by themselves. The number made up at Bombay was written in English, French and Gujerati.

Official estimates for 1895 place the steam power used in the German empire as follows: Stationary steam boilers, 88,332; stationary steam engines, 89,936, producing 3,312,357 horse power; traction boilers, 25,884; engines, 25,322, producing 242,338 horse power; marine boilers, 4,269; engines, 3,235, producing 902,793 horse power; or a total of 115,000 stationary and traction steam engines, producing 3,500,000 horse power. This does not include the steam power used in the military shops, naval yards and railway service, the figures of which are not published.

A parcel post has been established between the United Kingdom and Switzerland on the terms of an agreement just published by the British post office. Parcels may be sent to Switzerland, up to the weight of 11 pounds, and from Switzerland to the United Kingdom, up to the weight of 5 kilogrammes. Insurance can be effected as high as £50 sterling, or 1,250 francs. The rates of postage, not including 25 centimes for registration on an insured parcel, amount to 1 franc 85 centimes for 3 pounds weight, 2 francs 35 centimes for a parcel not exceeding 7 pounds and 2 francs 85 centimes when it does not exceed 11 pounds. Indemnity for loss will be paid to the extent of 25 francs.

A machine for catching flies off the backs of cattle, and so affording the animals relief and comfort, has been invented by a farmer in Kentucky. The fly catcher is a kind of covered pen or passageway, through which the animal must walk to secure relief. A few feet from the entrance there is a cupola or dome in the roof of the passageway, made of glass and arranged as a fly trap. Beyond this the passage is darkness. The animal walks through the machine, and just as it passes under the dome and enters the darkened part a set of brushes sweeps off the flies, which naturally rise into the lighted dome, and the steer passes out at the other side free of flies. The flies are retained in the dome trap. The inventor has experimented with his machine and finds that the animals soon learn the value of the machine and know enough to walk through it when the flies begin to bite.

The last two numbers of the Indian Magazine contain a list of all the natives of India residing in England, almost all for study. The total is just 300; and there are 30 women in addition, mostly Bengalis or Parsis. As compared with former lists, the notable feature is the increase in Mohammedans—from the Punjab and Behar. It may be remembered that the only Indian who passed for the civil service last year was a Mohammedan. Madras is still very poorly represented, as also are the northwestern provinces. Among native states, the proportion from Baroda and Kathiawar is remarkable. Cambridge seems much more attractive than Oxford; but the great majority are in London, reading for the bar. It may, however, be observed that, out of less than a dozen Baroda students, two are studying agriculture, one is studying music, one engineering, one banking, one watch making, one cabinet making, and one pottery.

The manufacture of paper in Finland has increased to such an extent in recent years that it now forms one of the most important industries in the country. There are, according to the Papier Zeitung, 13 paper mills, 7 chemical pulp factories, 3 straw pulp and 20 wood pulp and pasteboard factories. The number of workmen employed in these different factories amounted to 3,847 in 1894. In 1893 the production amounted to 32,000 metric tons of mechanical wood pulp, 8,000 of chemical and 7,500 of paper. The factories chiefly employ English machines, but recently German and Swiss makers have received orders. The total number of paper machines in Finland is 26. Two mills only make rag paper; two mix rags with first-class paper; three add straw pulp; and all the others make wood paper exclusively, and at need employ chemical pulp. The rags are imported from Russia, the total imports being 1,220 metric tons in 1891, 867 in 1892 and 727 in 1893.

The Engineering and Mining Journal says: "For the past year or two a good deal of apprehension has been felt by phosphate producers in this country and elsewhere as to the competition of the African deposits. . . . . The Tunisian mines are not yet worked to any considerable extent, and, according to L'Engrais, the total production of Algeria in 1895 was 121,475 metric tons, which is only a very small amount compared with the total consumption of Europe alone. At present very little work is in progress, owing to the difficulties over the concessions at Tebessa and elsewhere. Our Florida producers have, apparently, no occasion to be alarmed at African competition for some years to come. A more formidable interference with their business is found in the rapidly increasing use of Thomas slag as a source of supply of phosphoric acid. The quantity of this slag produced in Germany and Belgium is growing, and its application in the manufacture of fertilizers has been promoted by its abundance and cheapness, so that it has become a considerable article of commerce."

VERTICAL AND HORIZONTAL PLANING MACHINE.

The vertical and horizontal planing machine which we illustrate on the present page, and for which we are indebted to London Engineering, has been designed by Messrs. Thomas Shanks & Company, Johnstone, to enable such a machine to deal with slotting keyways in wheels up to 10 feet in diameter, without in any way destroying the stability of the machine for dealing with ordinary planing and slotting.

It will be seen in the illustration that there are two portable base plates 24 inches deep, but there is also (not shown) a table 6 feet 2 inches square, with an insetting slide, which is also 24 inches deep, and which is placed between the two base plates. This table is made to rotate by self-acting details. The other details of the machine have the latest improvements for dealing with sugar mill machinery and millwright work. The machine itself is placed in the extensive new works of Messrs. A. & P. W. McOnie, Glasgow, called the Cessnock Engine Works, Copeland Road, Govan.

IN A FLOUR TESTING LABORATORY.

In making flour tests considerable trouble is often experienced in rendering a decision on the color. Some people are subject to color blindness, which is a great drawback to their detecting differences between shades of flour or ground materials. It is becoming quite customary for the mills of large capacity to adopt a flour testing laboratory for the purpose of keeping tab on its grades, and to reduce the art of flour making to a science. Machinery has done a great deal for the flour miller. But it remained for cool, calculating science to step in and with chemical and physical tests permit him to tell how many drachms of gluten a pound of flour contains; how much starch the wheat contains when it arrives at the mill, or how much water a barrel of his product will absorb at the hands of the cook in the metropolitan bakery before it is an eatable food.

The testing laboratory is the home of all the science that the miller needs to know. In the long rows of glass jars with their whitish and creamish contents lurk the results of experiments made for years back. In the electrically heated oven, always at the same temperature year in and year out, little fluffy white loaves have been turned out by the hundreds that would have delighted the most particular of housewives. With his delicate apparatus the flour tester can tell minutely whether the patent or bakers' grade of today differs from that of yesterday and in what respect and how to remedy the difficulty. And therein lies the triumph of science as practically applied, for without its aid there would be no means of keeping grades always the same month after month, and when the quality of wheat was continually changing. If it were not for this tester a family grade would sometimes excel the best patents and again it might fall below the level of red dog and kindred cheap flours.

The flour tester, like the tea tester, is an expert. Some things he knows intuitively or from long practical experience. Others he knows because the principles of physics make them apparent. With these two sources of information the tester arrives at conclusions which are accurate and which furnish proof of themselves in each other. He does not rely upon any one test for his information. In all he uses six or eight methods and each proves the other, so that when he announces his dictum concerning the grade, deficient or of overquality, the miller acts without loss of time. In his department the flour tester is supreme. If he reports that a grade is lacking, the head miller takes his advice and furnishes a remedy. If it is granulated too fine, the bolting cloth is changed. If it is too dark in color, too much of the bran is going into the flour and the separation process is looked after more closely. If the grade is running better than is called for, the change is made in the reverse directions.

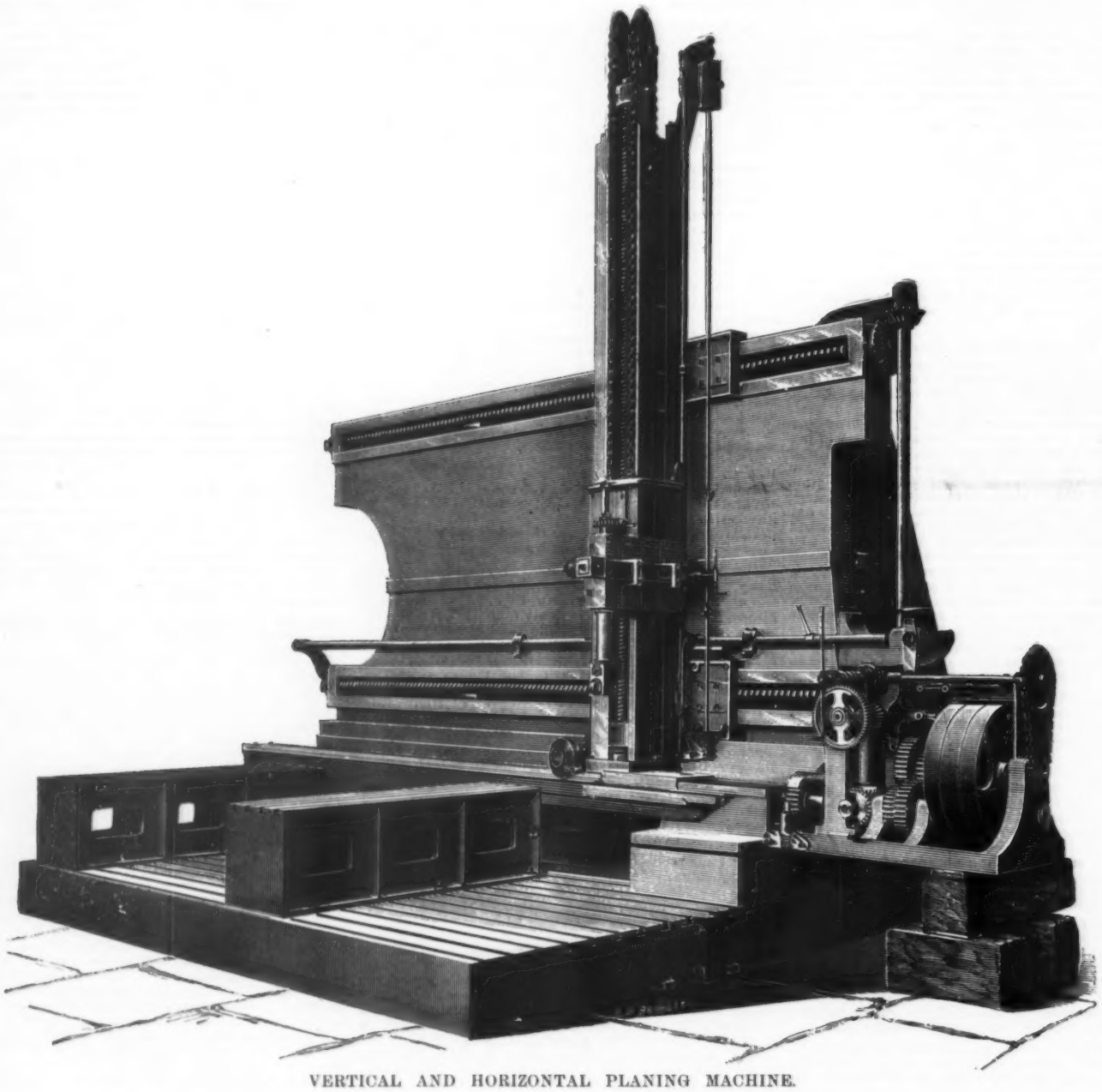
The laboratory of the tester as nearly resembles the den of a private chemist as one can imagine. The inevitable row of chemicals—red, white, creamish and yellow—are in their glass stoppered bottles behind the door of the glass cabinet. Under a glass case in the corner, safe from dust corrosion, stands the delicate balance scales weighing to a hair's accuracy. In the other corner is the everpresent bottle of distilled water with miniature hose attached, and in the center of the room the working table stands ready for use, covered with half a hundred small, square boxes containing samples of wheat, flour, bran, shorts, and everything turned out by the mill, down to the coarsest screenings. On the opposite side of the room is the warming oven, showing the fermenting bread in various stages of rising, from that just kneaded to the loaf which will, within a very short time, find its way into the baking oven. Baking ovens vary. Some testers use a gasheated affair resembling in appearance the broiling oven in a restaurant, while others have adopted electricity. A circular appearing affair with an outside covering of wood resembling a large cask somewhat is the latest in electrical baking ovens, and this is coming to be quite generally adopted.

The Pekar method so called, or "under the slick" test, is in most common use in testing flour, but it is considered far from infallible. Comparing flours side by side is likely to cause an error in detecting the shades of variation. A direct sunlight will often cause deception even with the best of eyes.

The ordinary test of wetting a slab of the flour and allowing the same to dry essentially consists of studying a thin film of dough overlying a mass of the flour. This film is so thin that the grain of coarse flours is distinctly seen through it. During this test there are two distinct actions going on, and possibly simultaneously. As soon as dry, the wetted up flour is much darker than was the flour taken in its dry state; but in the course of a few hours the flour decidedly loses its depth of tint.

An oxidation process causes a darkening (browning) of the tint, while the color is also more or less discharged by a bleaching action. A prominent authority in making a series of tests has concluded that these two effects occur with different constituents of the flour, inasmuch as flour when treated with cold petroleum spirit for the purpose of extricating the fat, causes the flour to be left in a comparatively white condition, on evaporation of the spirit. If this be now formed into a slab and wetted, the slab shows, especially in the darker flours, a distinct darkening of color. The spirit solution being evaporated leaves the fat of the flour tinted a deep yellow by the coloring matter present. By exposure to sunlight the fat may be completely bleached. It is but reasonable to believe that unsuspected variations and discrepancies in the color of the flour after wetting may be due to alteration in the conditions, which may in one case favor the bleaching action and in another hasten the browning process.

What is known as the baking process is resorted to as a safeguard to show that the flour is the same after baking as before. The recipes advocated in the advertisements of the various mills are followed with the greatest exactness, so that bread is baked as others are advised to make it. The yeast and flour are mixed together and the dough is set away to ferment in a rising oven kept at an even temperature throughout the day summer and winter, so that the conditions of baking should always be the same and the result should bear out the conditions of flour, yeast, etc. Bread in the testing room is set to rise in dishes four or five inches in depth and in circular form, the ware absorbing the heat on all sides and warming the dough evenly throughout.



VERTICAL AND HORIZONTAL PLANING MACHINE.

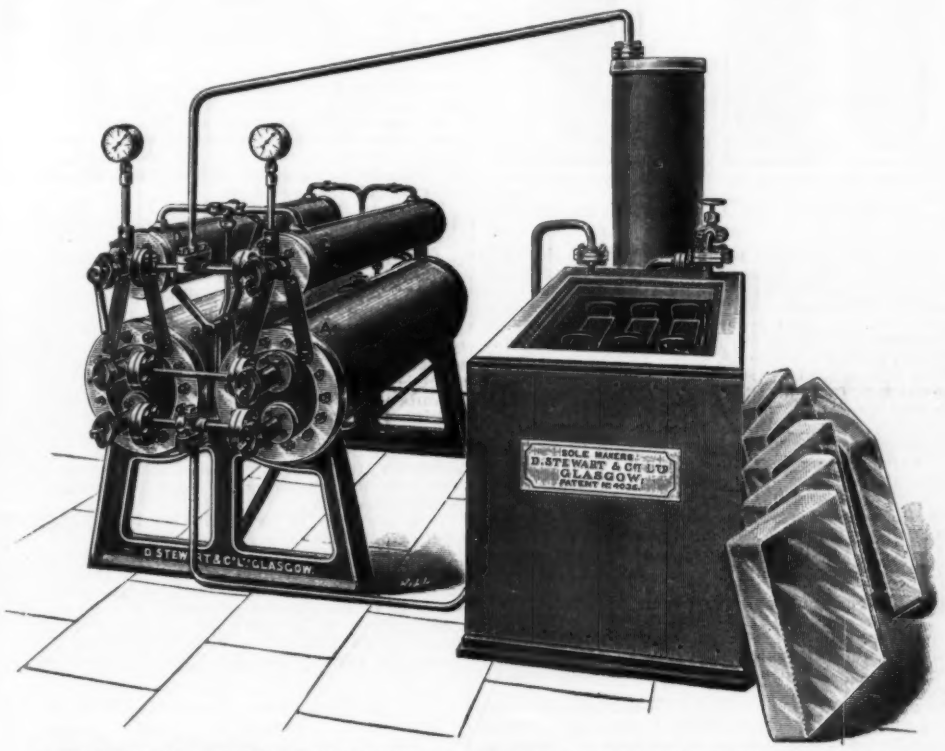
About four hours is required for this part of the operation, and then follows the baking process. The loaf is put into an oven kept at an even temperature of 375° and is baked rapidly. After comparisons have been made the miniature loaves are given away to deserving poor, a record having been made of the results.

These tests have so far been perfectly simple, and by the time they have been completed the tester is pretty well assured of the exact status of the run. Next in order his knowledge of chemistry becomes an important factor; especially is this true when the new crop wheat is being brought to market. The laboratory feature consists in separating the gluten and extracting the starch from other chemical ingredients in both the flour and the wheat for purposes of comparison. It is one of the frequently circulated calumnies that spring wheat is losing its glutinous qualities. For that reason the big millers up at Minneapolis keep an accurate tabulated account of their experiments to refute this slander. Every autumn and fall they find out exactly whether or not the wheat they are purchasing is as good as that of the previous year, and whether the flour made from it contains as much gluten.

A drachm of flour is first placed on a piece of fine bolting cloth, and the distilled water is blown through it by means of the long hose connection. The starch flows through with the water and the gluten remains on the meshes of the bolting cloth. To dry it out the gluten is "dumped" on short, narrow strips of glass and put in an oven, the double walls of which are filled with water kept at the boiling point by a Bunsen burner. It is left there for four days and at the end of the time is weighed. The exact proportion of the straw colored gluten is easily arrived at. In spring wheat flour it is from 11 to 13 per cent. and in winter wheat brands of the best grade from 4 to 8 per cent. When dried on the glass strip it is almost impossible to detach the gluten, and in attempting a separation many times pieces have been taken out of the strip by its strength. The residue is largely starch, although there are slight traces of other minerals.

The results of all tests are kept in records for the purpose. During the last year some interesting results have been brought to light by testers in Minneapolis. Buda-Pesth flour has a reputation world wide for general excellence. However, an analysis shows that the millers have no share in creating its fame, for in general granulation it is much coarser than the better American brands, and as a general thing it is not so well milled. Its principal characteristic is an abundance of gluten—from 2 to 4 per cent. more than is found in the American spring wheat grades. Kansas red wheat brands of flour have been put upon the market as something extraordinary, but analyses made in Minneapolis show that they have less gluten and consequently a smaller proportion of nutritive value.

The whole testing system makes it impossible to cover up any discrepancies in grain or milling, and it is the framework on which the miller builds. It is valuable to the consumer as well, for he gets exactly what he pays for when he patronizes any of the modern milling concerns, and by some of the simplest tests he can prove if he desires whether or not he is getting a grade that is represented to be of a certain standard.—Milling.



THE SIMPLEX ICE-MAKING MACHINE—GENERAL VIEW OF COMPLETE PLANT.

THE SIMPLEX ICE-MAKING MACHINE.

THE Simplex ice-making and refrigerating machine shown is capable of making 10 cwt. of ice per day of twenty-four hours. The apparatus works on the ammonia absorption system, and is operated by steam. It consists of two steel cylindrical ammonia heaters, inclosed in steel casings and containing coils of iron pipes. These cylinders are charged with a solution of ammonia, one charge being sufficient for twelve months working. Above these vessels are fixed two similar but smaller vessels without coils, known as rectifiers. A pipe runs from these two vessels to a vertical cylinder at the rear, fitted with iron coils. This vessel acts as a condenser, and is fitted with a cold water jacket, in order to cool the gas. The ice box consists of an iron tank, lagged with wood. Inside this tank is an iron coil, surrounded by a solution of brine, one end of which is connected to the coil in the condenser, and the other end to the two large horizontal cylinders. Galvanized steel cans or moulds containing the water to be frozen into blocks of ice are placed in this brine, there being nine of these moulds in the tank shown at the exhibition. Coming now to a brief description of the operation of the machine, the heat of the steam circulated in the coils of one of the two large horizontal cylinders containing the solution of ammonia causes ammonia gas to be generated. This gas passes through the rectifier to the condenser, where it is condensed into pure liquid ammonia, the gas entering at the top. The outlet pipe for the liquid is at the bottom of the cylinder, and is connected to an expansion valve, which is only opened about $\frac{1}{10}$ inch, so allowing only one drop at a time of the liquid to pass into the coil in the ice box or tank, where it immediately expands, and again assumes a gaseous form. The cold is produced owing to the peculiar property of ammonia, which under certain conditions has a temperature of 30° F. below zero or 60° below the freezing point of water. In passing through the coil in the ice box it is made more or less to assume these conditions, with the result that the brine surrounding the coil is cooled to a very low temperature also, and this in turn cools the water contained in the cans, freezing it into solid blocks of ice. After passing through the coil in the ice box the ammonia returns to the other of the large cylinders, and after all the ammonia has been driven out of one cylinder into the other (which takes about one hour), the operation has to be reversed by opening and closing several valves, the operation being then carried on in a similar way, but in the reverse direction. Thus the same ammonia is used over and over again, and as the vessels and coils containing it are hermetically sealed, there is no waste. The machine shown is intended to be supplied with steam by a 2 horse power boiler, at a pressure of 45 lb., the cost of fuel being estimated at 2½d. per hour. The machine can also be arranged to work in combination with a gas-fired boiler and with super-heated steam. The productive capacity of the machine varies according to the climate, but in this country it will, as before mentioned, produce about 10 cwt. per twenty-four hours. About eight hours are required to freeze into ice the water contained in the nine moulds in the tank, this being equal to 3½ cwt., while under certain conditions 7 cwt. of ice may be obtained in twelve hours. By the addition of an agitator the machine can be arranged to produce what is known as crystalline ice, while the ammonia-generating portion of the plant can also be adapted for cooling and refrigerating purposes of all kinds. Having no moving part, there is practically no wear and tear in the machine, while it requires no foundations. The machine begins to freeze within a few minutes after starting to work, and is continuous in its action.

This machine is built by Duncan Stewart & Co., Ltd., of Glasgow, Scotland, and we are indebted to Industries and Iron for the cut and article.

FINISHING GLOSSES FOR LEATHER WORKERS, ETC.

TO FINISH THE EDGES OF BOOKS.

PUT a board each side of the book and clamp up firmly in the screw press, then rub the burnisher (steel, agate, or bone) over the edges when the stain has dried, and continue rubbing the burnisher over the edges until a fair luster is obtained. Allow the edges to dry, turn the book about in the press, and proceed to burnish the front in a similar manner, and finally put a higher gloss on the top and bottom edges by again lightly burnishing them. If the top edges (or all of them) are gilt, allow the gold to become perfectly dry before using the burnisher, or otherwise you will have the gold rub off under the burnisher in little pellets, and the edges be smeared and the labor wasted.

A BLACK LEATHER REVIVER OR RESTORER

for renovating shabby morocco, leather bags, dressing cases, etc., is prepared as follows:

Ingredients—	
Water	8 quarts.
Chip logwood	7½ oz.
Sugar	1 "
Genuine gum Arabic	6 "
Solution of sulphate of iron.	
Methyl alcohol.	

Method of Preparation.—Put the water and logwood chips into a copper boiler or saucepan, and let the water boil until reduced one-half in bulk. Then stir in the sugar and gum, and when they are dissolved stir in sufficient of the sulphate of iron solution to cause the reddish brown color of the solution to assume a plum or bluish tint. Then add the alcohol, and after a few days' digestion strain off for use. Apply one or more coats of this solution to the shabby leather with a sponge. If the grain of the leather is very much abraded or rubbed off, a final coat of a spirit gloss or lacquer will restore the new appearance of the bag, or whatever the article may be.

A SUITABLE GLOSS

for restoring shabby morocco or roan leathers, any color, is the following:

Ingredients—	
Methyl alcohol	1⅛ pints.*
Ruby shellac	6 oz.
Venice turpentine	1¾ drachm.
Sandarac resin	1¾ "
Castor oil	1¾ "
Nigrosine soluble in alcohol (or any other aniline dye, according to color)	¼ oz.

Method of Preparation.—Dissolve the dye in the alcohol, put in a stoneware or strong glass or tin bottle, then put in all the other ingredients and stand the bottle on some hot sand or in a vessel of hot water, which gradually raise to a boil. Lay this lacquer or gloss on the leather with a soft-haired varnish brush.

GLOSS FOR BOOKBINDERS' CLOTH.

Ingredients—	
Methyl alcohol	3 pints.
Shellac, orange or ruby, according to color desired	1¼ lb.
Oil of turpentine	2 fl. oz.

Method of Preparation.—Dissolve the shellac by slow digestion in the alcohol, and then add the turpentine.

COLORLESS GLOSS FOR BOOKBINDERS' USE.

Ingredients—	
Methyl alcohol	1⅛ pint.
Bleached shellac	21 oz.
Oil of lavender	¾ fl. oz.

Method of Preparation.—Use the freshly bleached shellac. Dissolve this in the alcohol by slow digestion at a gentle heat, and then add the essential oil; the latter ingredient renders the gloss flexible and prevents it being brittle.

BROWN GLOSS FOR BOOKBINDERS.

Ingredients—	
Rectified alcohol	5⅛ pints.
Orange shellac	17½ oz.
Gamboge, powdered	2 "
Oil of lavender (avoirdupois weight)	1 "

Method of Preparation.—Digest the gamboge in the alcohol until the fluid ceases to deepen in color, then dissolve therein the shellac, and when this is dissolved add the oil of lavender.

LOGWOOD BLACK LEATHER GLOSS.

Aniline blacks have driven out of use logwood blacks to a large extent, but with some kinds of leather a logwood black is preferable to an aniline dye one. The following gloss is suitable for sumac tanned goods, such as skivers and split leather:

Ingredients—	
Methyl alcohol (i. e., 5 qts.)	200 fl. oz.
Solid extract of logwood	2½ oz.
Bichromate of potash in very fine powder	½ "
Indigo carmine (if bluish gloss is required)	2½ to 5 oz.
Orange shellac	5 oz.
Turpentine	25 fl. oz.

Method of Preparation.—Dissolve the shellac in the turpentine up to a gentle heat, and in a separate vessel dissolve the logwood extract in the alcohol, then add to it the bichromate of potash (this may be previously dissolved in a little water, or by rubbing it up in alcohol), then mix the turpentine solution of shellac with the alcoholic solution of logwood. To give a bluish tinge to the gloss, if required, dissolve the indigo carmine in the compound, after mixing the logwood and shellac solutions.

COLORLESS GLOSS FOR BOOKBINDERS' CLOTH.

Ingredients—	
Methyl alcohol	5 pints.
Oil of turpentine	5 "
West India copal resin	5 "
Mastic resin	1 "

Method of Preparation.—Digest for a few hours separately the mastic in the turpentine and the copal in the alcohol, and then mix the two compounds and gently heat the mixture until the solids are dissolved.

FLEXIBLE GLOSS FOR LEATHER.

Linseed oil varnish (manganese linoleate)	1 quart.
Oil of turpentine	½ pint.
Benzole	½ "
Rectified alcohol	½ "
Mineral asphaltum	10 oz.
Tar asphaltum	10 "
White wax	2 "
Paraffin wax	3 "
American pine resin	10 "
Paris blue	2 "
Methyl violet (magenta)	11 "

Method of Preparation.—Dissolve the aniline dye

* The English pint is 20 fluid ounces.

(methyl violet) in the alcohol separately. In a suitable vessel melt together the asphaltum resin, wax, and paraffin wax. When this is melted, stir it well, and then put in the linseed oil and blue pigment. Stand the vessel on a sand bath, and heat until heavy vapor begins to be evolved, stirring it all the time. Sample the compound from time to time by testing how far it can be drawn into thread and leave no fat-like edges when dropped hot on a piece of paper; when this stage is reached, let the compound cool down sufficiently to add the turpentine and benzole safely (if the temperature be too high, this highly inflammable fluid will ignite), and well mix the whole by stirring. This gloss is a very useful one for general purposes, and for use on leather; several coats of it will produce an enamel-like appearance resembling patent leather.

GOLD COLORED GLOSS FOR LEATHER CLOTH AND LEATHERETTE.

Ingredients—	
Seedlac	35 parts.
Sandarac resin	35 "
Venice turpentine	2 "
Oil of turpentine	3 "
Gamboge	14 "

Method of Preparation.—Digest the gamboge in the oil of turpentine at a gentle heat, and then put in the other ingredients, and heat until dissolved.

CHEAP VARNISH FOR BOOKBINDERS' CLOTH.

Ingredients—	
Orange shellac	¾ lb.
Crystallized carbonate of soda	1 oz.
Water	3 pints.

Method of Preparation.—Put the soda into the water and bring the latter to a boil, then put in the shellac and continue the boiling until no more shellac will dissolve, strain the fluid while hot through a cloth or hair sieve, and keep the clear solution for use. The best solvent of shellac, to make an aqueous solution, is ammonia, in the proportion of 1 part of ammonia to 2 parts of shellac and 40 parts of water. Borax is the general agent used, but water will not dissolve more than 4 oz. of shellac per gallon of water. To make a liquid solution a larger proportion of shellac can be dissolved, but the result is a pasty compound.

BOOKBINDERS' SPIRIT VARNISHES.

Ingredients—	
Methyl alcohol	1¼ pint.
Spirits of turpentine	3 fl. oz.
Mastic resin	6 oz.

Method of Preparation.—Dissolve the resin in the spirits by aid of a gentle heat. To prevent the mastic cohering and so hinder its solution, about 3 oz. of coarsely powdered flint glass (free from dust) may be mixed with the resin before adding the spirit. When all the resin has dissolved, and only a dirty deposit left as a sediment, pour in the turpentine and raise the heat until the fluid boils, using a sand or water bath, so as not to crack the vessel. Let it boil for 30 minutes, then set it aside to cool, and strain through cotton cloth to free the liquid varnish from the glass and sediment. This varnish is apt to be rather friable.

SPECIAL VARNISH FOR BOOKBINDERS.

Ingredients—	
Methyl alcohol	3 pints.
Gum elemi (elemi resin)	¼ lb.
Mastic resin	½ "
Venice turpentine	6 oz.
Sandarac resin	¾ lb.

Method of Preparation.—Put all the ingredients into a stoneware, glass, or metal vessel, and gently heat the contents until the solids are dissolved. A slight improvement is to reserve the Venice turpentine until the last, and put that into the mixture when the solids are dissolved.

A VERY SIMPLE VARNISH FOR BOOKBINDERS

is a solution of sandarac resin in spirits of wine; 3 oz. of resin to the pint of spirits. Digest by cold solution, and let rest a week before use, pouring off the clear fluid from the sediment.

A VERY FLEXIBLE VARNISH FOR BAGS.

Burnt umber	⅛ lb.
Asphaltum	¼ "
Linseed oil	1 gal.

Method of Preparation.—Dissolve the asphaltum in a little of the oil by a gentle heat, and separately grind up the umber with sufficient oil; finally mix the two and add the remainder of the oil, then heat the compound until it boils, and thin it for use by the addition of turpentine when cooled sufficiently.

This compound is very flexible and forms a good enamel or japan for leather.—The Stationery Trades Journal.

APPARATUS FOR THE MANUFACTURE OF ACETYLENE GAS.*

III.

THE Ducretet and Lejeune Apparatus (Figs. 18, 19, and 20).—Messrs. Ducretet and Lejeune are manufacturing two kinds of apparatus serving for the production of acetylene—one of them under all pressures and the other under a reduced pressure.

The first, represented in Fig. 18, consists of a receptacle, B, containing the carbide and closed by a cover with a hermetical joint, and above B a second receptacle, B', containing the quantity of water necessary to decompose the carbide contained in B. These two parts are directly connected by the piece, A, or by tubes of proper length provided with stopcocks.

The water flows from B' to B through the internal tube, T. The second tube, T', establishes an equality of pressure between G and G'. Consequently, for all pressures, the water must flow into B through its own pressure resulting from the height that separates the two receptacles.

Beneath the cover there is a device for regulating the discharge of the water. As soon as the latter comes into contact with the carbide it produces a disengagement of acetylene, which is utilized upon its egress from the cock, A'. As soon as the pressure that it is desired to reach exceeds the limit of the regulation of the screw, Re, it acts upon a disk that communicates with the external air. This disk is, consequently, jammed upon its seat and leaves the internal spring free.

The valve that it controls then closes the internal orifice of the tube, T, and the flow of the water is arrested.

The distribution of the water over the carbide is effected in the following manner (Fig. 19):

The carbide is placed in one or more perforated receptacles, S S, leaving a small space between them and the vessel, B. The water flows to the interior through a funnel and the slit tube, D, and reaches the lower part of B. The water thus attacks the carbide from bottom to top. The lower part of D is closed by the formation of the lime, but the water continues to flow through the slit in the tube, D.

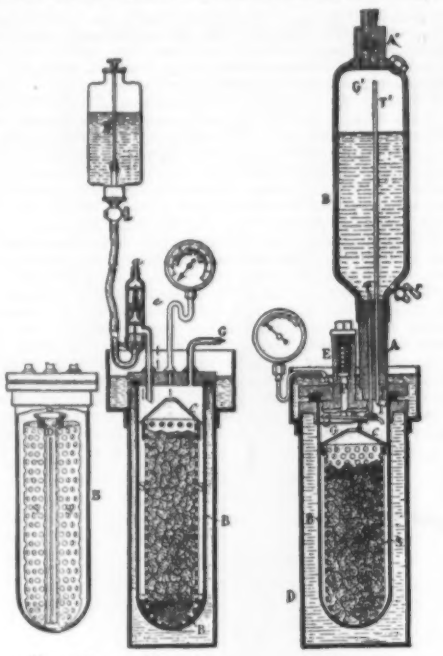


FIG. 19. FIG. 20. FIG. 18.

DUCRETET & LEJEUNE APPARATUS.

The second apparatus, shown in Fig. 20, contains, like the first, the same kind of carbide receptacle as the one just described. The water, which is contained in an upper reservoir, B, passes through a cock to a discharge regulator, e. This latter consists of a vertical free valve having a small column of water above it. Under the pressure of the water of the reservoir, B, the valve opens and allows the water to flow through the tube, T, upon the cap of the carbide receptacle, S. The gas produced is disengaged at G, and escapes through the tube, G. If the pressure at C becomes too strong, the valve, e, closes and arrests the flow of the water, which is resumed as soon as the pressure of the gas becomes normal again. Above e there is a safety valve of variable regulation that allows the gas to make its egress through a, in case of an abnormal pressure. The delivery tube, G, is connected with a pressure reducer of constant discharge, and after this comes a gasometer.

The Bullier Apparatus (Fig. 21).—Mr. Bullier's apparatus consists of a steel receptacle, A, supported through trunnions by a frame, so as to facilitate the cleaning. This is filled two-thirds full of water. The charging orifice is closed by a cover with a rubber washer and bolts with thumb nuts. In the center of the cover there is a stuffing box in which slides by friction a rod, D, that supports a perforated basket holding 11 pounds of carbide. Before the basket is lowered, a few pieces of carbide are thrown into the water through the aperture, C, which is closed by a cover fastened with a bridge and bolt. The gas formed expels the air from the apparatus, the escape cock, R''', of which has previously been opened. The gas disappears in the atmosphere in carrying along the air contained in the generator, in the worm, K, in the drier, H, and in the charging tube connected with the cock, R'''. At the end of a few minutes, the apparatus, as well as its accessories, is completely freed of air. The charging tube is screwed to the reservoir to be filled. The cock, R, is closed, and the apparatus is ready to operate.

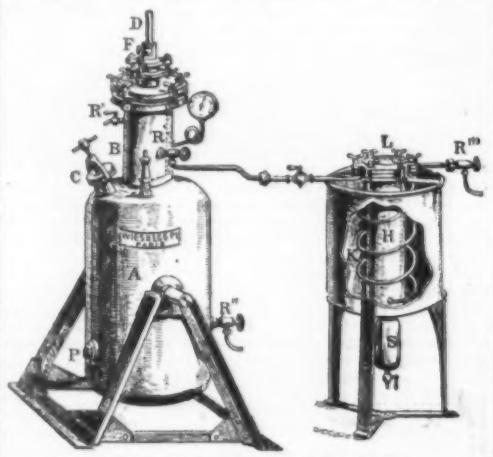


FIG. 21.—BULLIER APPARATUS.

The rod, D, is then gradually pushed downward so as to make the carbide enter the water progressively. If the pressure is too strong, a certain quantity of water is allowed to flow through the cock, R'', and the rod that carries the basket is raised. When the pressure, which is shown by a manometer, reaches that which it is desired to obtain in the reservoir to be charged, the cocks, R R''', are opened and the gas is allowed to enter the reservoir previously freed of air by one or two discharges of acetylene.

One continues to make the basket descend (in always watching the manometer) until the carbide is exhausted. The cover is then taken off, and the basket is removed, washed and dried. The milk of lime deposited at the bottom of the vessel is drawn off, and a new charging is effected if necessary.

Reservoirs of the Central Society of Chemical Products (Fig. 22).—These reservoirs are steel plate cylinders resisting 44 pounds and serving to store up acetylene compressed to a pressure not exceeding 22 pounds.

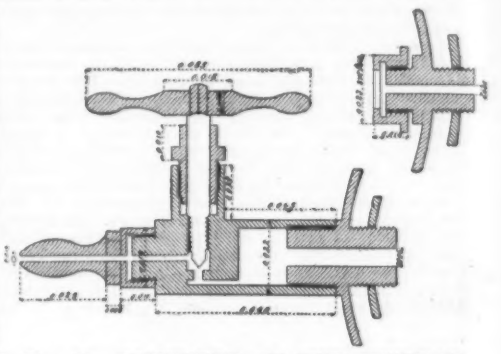


FIG. 22.—CYLINDERS OF THE CENTRAL SOCIETY OF CHEMICAL PRODUCTS.

At their lower part they are provided with a screw plug, and at the other extremity with a special cock that permits of supplying one or more lamps without an expander or regulator. These receptacles contain 9 cubic feet of compressed gas.

Dickerson Apparatus: a Third Form (Fig. 23).—In this apparatus, the carbide is contained in the chamber, A, closed by a slide valve and screw, F, forming a tight joint. Above this valve, in order to collect any small quantity of gas that may escape, there is arranged a receiver with a hydraulic joint connected by a flexible tube, H, with an eduction pipe, G, debouching into the atmosphere at a distance from the apparatus. The interior part of A consists of an inverted and an upright cone. At about 8 inches from the junction of these there is a grate, O, upon which rests the carbide. The chamber, A, is connected with a lower chamber, B, having an open bottom and resting through supports, S, upon the bottom of a tank, C, full of water, with an automatic feed, D, and a waste pipe, Q. This water serves for attacking the carbide and cooling the gas. The hydrated lime formed is capable of swelling freely in the space, O Y.

Near the grate, O, extending above and slightly beneath the latter, is located the gas pipe, M N, which is sufficiently wide to prevent the entrainment of the water. The gas disengaged through this pipe flows into a regulator, T, whenever it escapes through the pipe, Z, at the desired pressure. The object of this arrangement is to carry off the gas from the very point of its production without allowing it to traverse the mass of non-decomposed carbide and thus act upon this body through the humidity that it carries along.

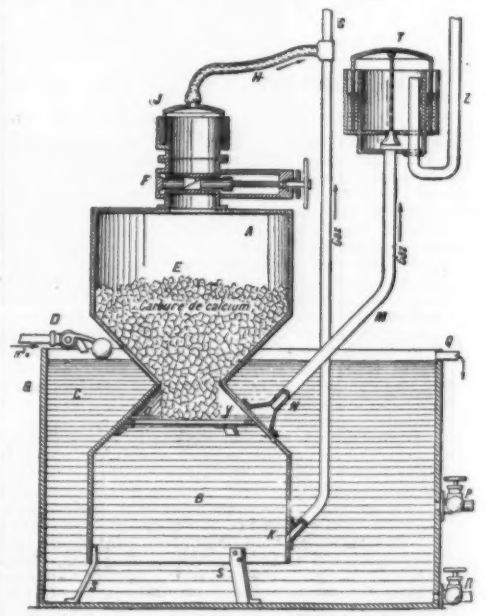


FIG. 23.—DICKERSON APPARATUS.

So long as the water is kept at a constant level, a, in the tank, the feed cock, D, remains closed. The chamber, B, is provided at its lower part with an aperture, K, in which ends the safety tube, K G, which debouches into the atmosphere. When the pressure of the gas at M N exceeds that which is desired at Z, the regulator, T, shuts off the egress of the gas. The excess of pressure in the chamber, A, forces the water in B to flow into the tank, C. The lime produced in the

* Continued from SUPPLEMENT, No. 1083, page 17315.

form of powder falls to the bottom of the tank and does not remain mixed with the carbide. As soon as the pressure decreases, the water comes into contact with the carbide again. The action of the water upon the carbide is thus rendered regular automatically.

If the gas is not utilized in measure as it is produced, or if, through an excess of pressure, it closes the regulator, it then distributes itself through the chamber, B. Although the water is no longer in contact with the carbide, the aqueous vapor nevertheless continues to attack it slowly. But the capacity of B should be sufficient to take charge of all the excess of gas thus formed.

The water that has flowed into the tank, C, escapes through the waste pipe, Q, placed above the level, a,

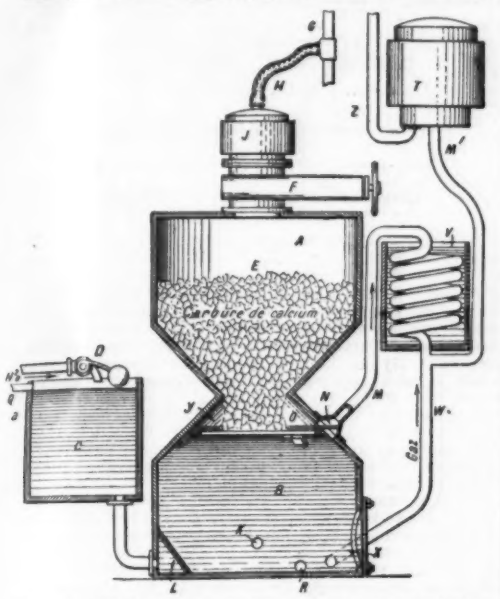


FIG. 24.—MODIFIED DICKERSON APPARATUS.

and does not allow of the opening of the feed cock, D. Should the level of the water in the chamber, B, descend below the orifice, K, the excess of gas would escape through the tube, G, which acts as a safety valve.

The tank, C, is provided with a waste cock, R, and is prolonged beyond the chamber, B, for the purpose of allowing the lime to be removed. The space is wide enough to allow a man to stand therein. The lime that has fallen to the bottom may be removed with a shovel or be collected in a movable trough.

The apparatus represented in Fig. 24 is a modification of the preceding. The chamber, B, is here closed. The water enters from the reservoir in traversing a sieve, L, designed to prevent the lime from entering the reservoir. The orifice, K, is connected with the safety tube, G, as before. This modified apparatus is provided with a special refrigeratory, V, that replaces the pipe, M, which, in the preceding system, passes through the mass of water in C in order that the vapor escaping with the gas may be condensed therein. At its exit from the worm, the gas flows to the regulator through the pipe, M', and the condensed water returns to the chamber, B, through the pipe, W. Finally, X is a manhole serving to allow of the removal of the lime.

It is to be remarked that, in these apparatus, the regulator, T, controls the entrance of the water at D, since such water enters into combination with the carbide only so long as the regulator permits of the flow of the gas already produced.—Le Genie Civil.

SUGGESTIONS IN WOOD WORKING FOR AMATEURS.

WITH an amateur it not infrequently happens that his work is spoiled for lack of attention to some little detail such as a regular workman would observe from force of habit. In the simple matter of gluing, for example, how rare it is to find an amateur who can do a good job in this line, yet gluing presents no real difficulties. The glue should be soaked in cold water overnight, the surplus water should then be poured off and the glue heated over a water bath. A little alcohol lamp (Fig. 2.) will produce sufficient heat to keep the glue liquid. This liquid glue can be used for cardboard and paper, as well as for wood, and many amateurs use it for securing their aristotype proofs on cardboard. When used for this latter purpose it is sufficient to pass a fine brush charged with glue rapidly over the edges of the photograph.

In gluing wood care should be taken not to have the glue too thick and not to use too much of it. It is generally sufficient to spread a thin coating of glue over the parts to be glued together. In order to secure ready spreading and rapid drying, the objects should be warmed before the glue is applied. The

FIG. 3.—Punches, Drill, Gimlet.

most important part of the operation of gluing is, perhaps, the application of pressure. This must be carefully attended to, for the firmness of the work depends largely on it. Special wood presses or clamps (Fig. 4 and Fig. 2) are very useful, but the amateur can obtain inexpensive substitutes, or he can make them himself, or in place of them he can use something that he may happen to have, and still obtain very good results. A copying press with sufficiently heavy weights will answer, or he can tie the glued parts together tightly with cords.

In the above there has been scarcely any question of joinery; that is, work done with the plane, the saw, the chisel, etc., on soft or, more rarely, hard wood. Here the amateur encounters his greatest difficulties. As a rule, he will content himself with having a professional make, under his direction, apparatus which requires much skill, while he does little things that can be made with the tools he has, such as the scroll saw (Fig. 1), arranged to work by hand or foot power, the drill, punch, gimlet or an ordinary knife. With these tools it is easy to make a number of small articles. Materials used for such work are the same as those employed in artistic carving and can be procured of an ordinary dealer. Walnut, ebony, pear wood, mahogany, maple or sycamore can be used, according to the purpose for which it is intended. If it is desired to reduce the expense as much as possible, the wood of cigar boxes can be utilized, and this wood can be obtained in various thicknesses. Some of the boxes are made of soft wood, while the wood of others is more difficult to work. The boards must be selected with a view to the purpose for which they are to be used.

For a picture frame, for instance, wood of a pretty color should be chosen, the thickness depending upon the design.

Whatever the work to be done, the paper bearing the design to be reproduced may be glued on the wood. When an operator has something more difficult to handle, for instance, a new apparatus, he should begin by drawing the different parts of the proper size, and then the drawing can either be traced on the wood by means of specially prepared paper or it can be glued directly on the board. The parts of the design should be so arranged on the board as to prevent waste of material between them. The glue must be spread on the wood and not on the paper, for otherwise the paper will not adhere properly and there will be wrinkles and blisters. When the design is not very complicated it is better to trace it directly on the wood, thus avoiding all the trouble of gluing on the paper and more particularly of removing it afterward.

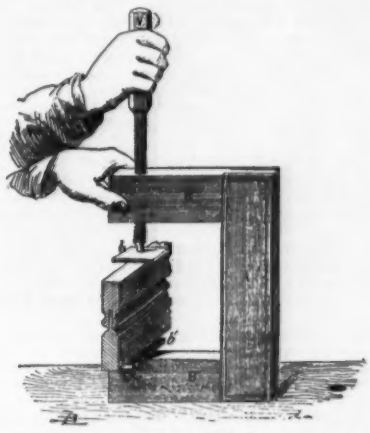


FIG. 4.—Gluing Two Pieces of Wood, M N.—A B B' V, hand press; b b', protectors.

Mr. De Graffigny uses the following method of tracing designs: Take some lampblack. If you have none, light an oil lamp, turn the wick down so that it will smoke, place a plate over the flame, and you will soon have what you need. Make a plug of a piece of old linen, put two or three drops of olive oil on it and then rub it first on the black and then on a sheet of ordinary paper. From time to time it will be necessary to add a drop of oil, so as to make the black adhere better. The plug should be kept and rubbed over the paper each time that it is to be used. When the paper is ready place it on the wood, black side down, lay the drawing on it and then trace all the outlines of the design with a blunt piece of steel or bone or with a lead pencil. By bearing on pretty hard the design will be reproduced on the wood, but all the contours must be followed carefully, so as not to alter the design.

In making an object composed of several parts, all the dimensions should be measured very accurately, so as to be sure that they will fit, before the design is transferred. In cutting, the outside of the tracing line should generally be followed. If it is found upon putting the parts together that they do not fit perfectly, the design can be altered accordingly, so that they will fit better the next time, for these patterns should be carefully preserved.

London omnibuses carried 79,000,000 passengers in the last six months, more than twice the population of Great Britain and Ireland. The receipts were $2,491,770 and the profits $326,695; 1,003 omnibuses traveled 11,688,000 miles.

FIG. 1.—Scroll Saw and Sawing Table.—T, board with notch, A C B, secured by screws, V V, to a wood press, P, which consists of a U-shaped piece of wood provided with a clamping screw, S.

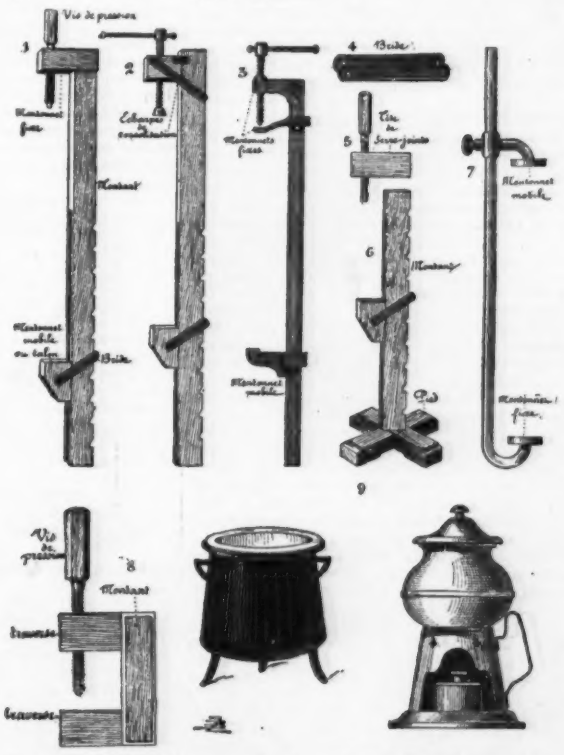


FIG. 2.—1 and 2, clamps made of wood; 3 and 7, clamps made of iron; 4, 5, and 6, clamp mounted on a foot; 8, hand press; 9, glue pots, the one at the right is set on an alcohol lamp.

ALTERNATE CURRENT TRANSFORMERS.*

By Dr. J. A. Fleming, F.R.S.

Lecture I.

THE ACTION OF THE TRANSFORMER.

In the last ten years the alternate current transformer has been developed from an experimental instrument into a practical appliance of immense utility. According to recent statistics, there are at present about fifty alternating current electric supply stations in the United Kingdom, supplying not less than 1,100,000 8 candle power lamps. This amount of lighting requires the expenditure of 54,000 horse power, or 40,800 kilowatts at full load, and hence there must be transformer capacity in the United Kingdom at the very least equal to 40,000 kilowatts. These transformers, as presently to be explained, all contain an iron core, which has to be magnetized and demagnetized 200 times a second, or 6,000,000 times a year. The total weight of iron cores in the whole of these transformers will be certainly not less than 400 tons, and it will require at least 400 kilowatts to maintain the magnetization of these cores. If these transformers are connected with the circuits only, on the average, 4,000 hours a year, it is very easy to see that the magnetization of the cores of the transformer will require not less than 1,600,000 Board of Trade units spent per annum in magnetism, and this means at least 16,000,000 pounds of coal, or 8,000 tons. Hence, in the United Kingdom, we have buried away somewhere or other at least 400 tons of iron forming the cores of transformers, and these involve at least an expenditure of 8,000 tons of coal, costing some £6,000 sterling to maintain that magnetization. It is, therefore, easily seen that the study of the construction of the alternate current transformer, and its possible improvement, is one which is not at all unimportant, from an engineering point of view.

I propose to assume in these lectures that the majority of those present are acquainted with the principal facts connected with the flow of alternating currents of electricity in inductive circuits, and to address myself more particularly to the study of alternating current transformers from a practical point of view, discussing in the four lectures of this course the action of the transformer, the construction of the transformer, the testing of the transformer, and the employment of the transformer.

You are all probably aware that an alternating current transformer in its simplest form consists of two circuits of insulated wire which are wound upon an iron core, and that this device operates to transform electric energy in such fashion that the flow of an alternating current through one circuit is made to produce another current in the second circuit, with an increase or decrease of current strength taking place at the expense of potentials. The transformer does no more than any lever, wheel and axle, or simple machine in transforming power from one form into another form. The general operation of the transformer or induction coil, in whatever form it may be taken, is then as follows: Through one of the circuits, called the primary circuit, is passed an intermittent, interrupted, or alternating current. This primary circuit is interlinked with a magnetic circuit, and the primary circuit establishes in the magnetic circuit an intermittent, interrupted, or alternating induction; the magnetic circuit is interlinked with a secondary circuit, and the variation of magnetic induction in the core creates an electromotive force in the secondary circuit, which at any instant depends upon the rate of change of the total induction linked with the secondary circuit.

As the word "induction" will very frequently be mentioned during the succeeding lectures, it is exceedingly important there should be no ambiguity in your minds as to the meaning of this term. We may help ourselves by regarding the analogy of conducting circuits and magnetic circuits. Consider a conducting circuit in which an electric current exists. As long as the circuit is closed we recognize the presence of the current, either by heat produced in the conductor or by electrolysis, and by various magnetic and dynamical actions in the medium round it. We select some one of these effects, say the electrolytic effect, and we base our quantitative definition of current strength upon it; thus, for instance, the accepted definition of an ampere is that it is a current which in one hour deposits, electrolytically, 4·025 grammes of silver. The cause, whatever its nature, producing the current is called the electromotive force. If we draw any line linked with or surrounding the conductor conveying the current, whether that line be included in a magnetic material like iron, or a non-magnetic material like air, we find a physical action taking place in that path which is called magnetic induction, and the immediate cause of this magnetic induction we speak of as magnetic force. We measure this induction by one of the effects it can produce, namely, by the electromotive force which it can set up in another conducting circuit linked with the magnetic circuit when that induction is suppressed or reversed at a given rate. Faraday showed that the proper measure of the total magnetic induction linked with any conducting circuit was the total quantity of electricity set flowing in the circuit when the magnetic induction is suppressed or reversed. In practical work it is better to abandon the rather academic phrase, "number of lines of force" or induction, so much used, and to think of the induction as a physical effect produced in the magnetic circuit, its value being reckoned in webers, the induction being produced in the magnetic circuit by magnetic force, just as electric current reckoned in amperes is produced in the conducting circuit by electromotive force. Hence we have this definition of a unit of magnetic induction. A unit of magnetic induction, called one weber, is an amount of induction which, when linked or unlinked with a circuit of one turn, and having a resistance of one ohm, causes one coulomb of electric quantity to flow round the conducting circuit. Generally speaking, if induction is measured in webers (1 weber = 10^8 C.G.S. units), we have the following relation between the magnetic induction, the number of turns or linkages which the secondary circuit makes round the line of the induction, the resistance in ohms of the secondary circuit, and the total quantity set flowing in the secondary circuit reckoned in coulombs.

Webers × linkages = coulombs × ohms.

Since one weber is a larger amount of induction than is met in any single transformer core or dynamo magnet, it is convenient to take the millionth part of this as the practical unit, viz., the microweber, and to commit to memory the following rule: Microwebers × linkages = microcoulombs × ohms, and to recollect that one microweber is equal to 100 C.G.S. units of induction, or what would commonly be called 100 lines of force. In order to measure induction, we require then a ballistic galvanometer as a practical instrument to measure electric quantity; and we can at once make a measurement of the induction in any magnetic circuit by determining the quantity of electricity set flowing in a circuit of a known number of turns which is linked with this induction, and then unlinked, by withdrawing the circuit or reversing the induction. As

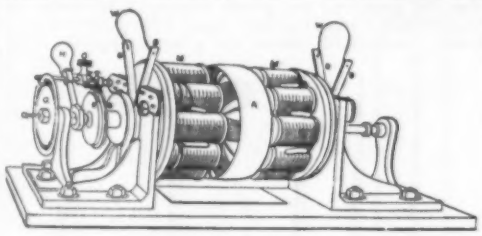


Fig. 1.

a practical illustration of these methods, it will be useful to make a measurement of the induction existing in this closed iron ring, when it is magnetized by a current flowing round it. The ring, as you see, is wound over closely with one layer of wire, which we will call the primary circuit. If we measure the mean perimeter of the ring, and count the number of turns, it is a simple matter to obtain the number of turns per centimeter.

If a current, measured in amperes, is set flowing through this circuit, then it can easily be shown that the magnetizing force acting upon the iron is equal to 1¼ times the turns of wire per centimeter, multiplied by the ampere current flowing through the circuit.* This magnetizing force produces in the iron a certain magnetic induction which is measurable in microwebers. In order to find out the magnitude of this induction, we put upon the ring a secondary circuit of a known number of turns. We then employ a ballastic

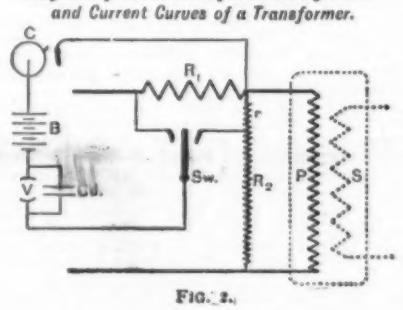
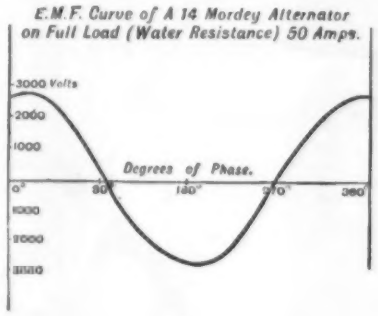


Diagram of Connections for obtaining E.M.F. and Current Curves of a Transformer.

Fig. 2.

galvanometer suitable for measuring electric quantity, and we must first calibrate this ballistic galvanometer to determine the excursion or throw of the needle, when a given quantity of electricity measured in microcoulombs is sent through it. This is most easily done by charging a condenser of half a microcoulomb by means of a standard cell having an electromotive force of 1·5 volts, and discharging this quantity of 1·5 × 0·5 = ¾ microcoulomb through the galvanometer. This produces a certain throw or excursion of the needle, and we may then assume that for any other throw of the needle the quantity of electricity producing it is proportional to the throw as determined by the above calibration. In order to measure the magnetic induction in the iron circuit, all that we have to do then is to connect the secondary circuit having a known number of turns, and the resistance of which, added to that of the galvanometer and connecting wires, must be determined in ohms, and observe the throw of the



E.M.F. Curve of A 14 Mordey Alternator on Full Load (Water Resistance) 50 Amps.

Fig. 3.

galvanometer needle which is produced when the primary current is reversed. Ascertaining from the previous calibration the electric quantity measured in microcoulombs represented by this throw, we multiply that number by the total resistance of the secondary circuit, including the galvanometer measured in ohms, and divide the product by the number of linkages or turns of the secondary circuit. This quotient gives us double the induction measured in microwebers existing in the iron core at the time when the steady current is flowing through the primary circuit, hence the induction is at once measured in microwebers.

Returning then to the alternate current transformer, we may classify transformers, converters, or induction coils as they are also called, according to their construction, and their use as follows: Transformers may be (a) iron core transformers with a core wholly or partly of iron, (b) air core transformers with a core or magnetic circuit wholly of non-magnetic substance. Iron core transformers may be (c) closed iron circuit transformers with a magnetic circuit wholly of iron, (d) open iron circuit transformers with a core partly of iron. Transformers may be used (e) to transform a potential difference in a constant ratio, in which case they are called constant ratio transformers, (f) to transform a current strength in a constant ratio, in which case they may be called constant transformers. The transformers may be employed (g) to raise pressure or current, and they are then called "step up" transformers, (h) to lower pressure or current, and then they are called "step down" transformers. This is not an exhaustive classification, but it is sufficient for practical purposes. By far the most important member of the group is the constant potential closed iron circuit transformer employed with alternating currents taken from a constant potential primary circuit. This may be considered from its importance to be the chief of the clan, and to it, therefore, we shall pay most attention. In order to possess a complete knowledge of the operations and action of such a transformer, we require to know the nature of the operations going on in all parts of it at the same instant. We have seen that the broad general action of the transformer as employed with alternating currents is as follows: If an alternating primary current is passed through the primary circuit, it acts upon the iron core with an alternating magnetic force, and creates in the iron core an alternating magnetic induction. If a secondary circuit is also wound round the same iron core, the periodic variation of magnetic induction in the magnetic circuit creates a periodic electromotive force in the secondary circuit; and if that circuit is closed, creates in it a periodic secondary current.

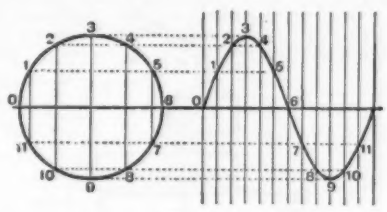
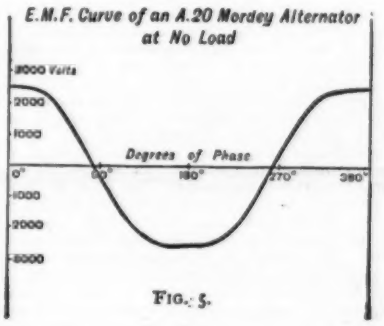


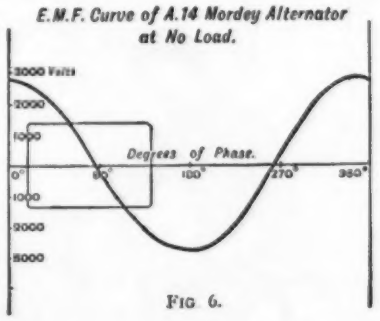
Fig. 4.

The method which of late years has proved most fertile in adding to our real knowledge of the subject of the transformer is that of delineating graphically the various periodic quantities concerned, by a process which is called alternating current curve tracing. It is, therefore, necessary to study this process in some detail. Suppose that we have an alternating current dynamo or alternator in operation, we know that the potential difference between the terminals of this machine undergoes periodic variation, and that it passes from one maximum in one direction to another maximum in an opposite direction. At any instant the machine is producing an electromotive force, which is called its instantaneous value. Suppose that the alter-



E.M.F. Curve of an A.20 Mordey Alternator at No Load

Fig. 5.



E.M.F. Curve of A.14 Mordey Alternator at No Load.

Fig. 6.

nator terminals are connected to a condenser, the potential difference of these condenser plates follows the same law of variation as the electromotive force of the machine. If the condenser is removed at any instant, and the potential difference of its plates examined, that will give us the potential difference of the terminals of the alternator, or the electromotive force of the alternator, at the instant when the condenser was disconnected.

The practical arrangements made for doing this, which I have found it convenient to use, are as follows: A small alternating current motor (see Fig. 1) has its field magnets excited by a constant continuous current, and its armature traversed by a current coming from the alternator under examination. The shaft

* Lecture before the Society of Arts. From the Journal of the Society.

* Vide "The Alternate Current Transformer," Fleming. New edition. Vol. i, p. 98. The Electrician Printing and Publishing Company, 1 Salisbury Court, Fleet Street, E. C.

of this alternating current motor carries an ebonite disk, on which is placed a small steel slip. As the disk rotates, the steel slip passes at each revolution underneath two small steel springs, lightly touching the ebonite disk. The steel slip, therefore, electrically connects these springs (which are otherwise insulated) together, and this connection takes place at each revo-

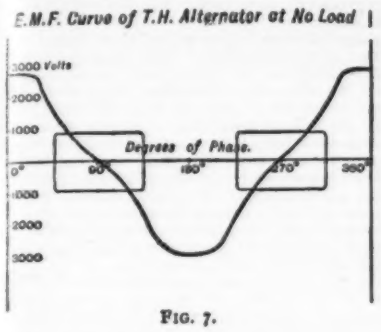


FIG. 7.

lution. The two springs are carried on an insulated bar, which is capable of being moved round an arc of a circle in such a manner that the instant when the springs are connected together can be altered and determined by the angular position of the rocking bar, carrying the two springs as read off on a scale. If this little alternating current motor is started in step with

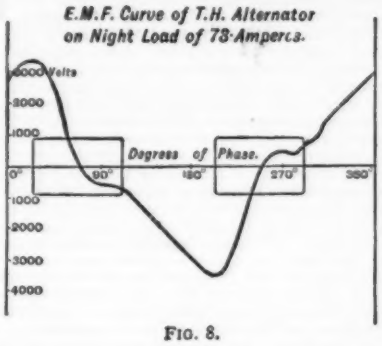


FIG. 8.

the alternating current machine, it will keep in step with it, and will close the circuit of the two springs once during every revolution at an instant during the complete phase of the electromotive force depending on the position of the springs. These two springs, constituting the revolving contact breaker, are connected in series with a small battery of Lithanode cells, B (see

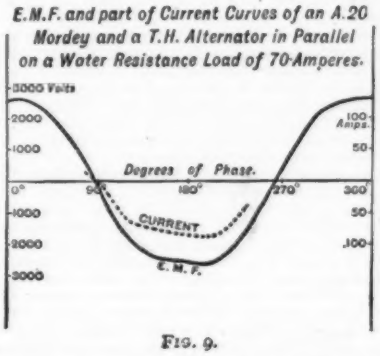


FIG. 9.

Fig. 2), and these again with an electrostatic voltmeter, V, across the terminals of which a condenser, Cd, is joined.

This appliance may then be employed to determine the form of the curve of an alternating current or an electromotive force as follows: Suppose it be desired to determine the curve of electromotive force of any alter-

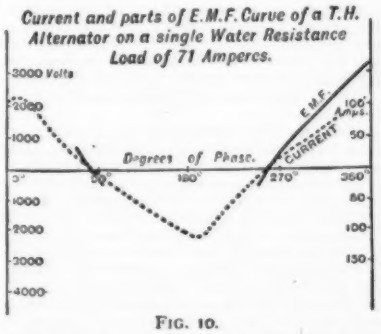


FIG. 10.

nator, the contact breaker is joined across the terminals of the alternator, and the reading of the voltmeter is taken as the rocking arm carrying the springs is moved round by steps through an angular interval corresponding to one complete period. At equal intervals during the movement, the electrostatic voltmeter is read, and in order to bring the readings within the best part of the scale of the voltmeter, a selected number of the cells of the battery, B, are placed in series with the voltmeter so as to add a known electromotive force to the electromotive force being measured.* By the employment of a revolving contact breaker of this form, a number of curves were taken from the alternating current machines in the City of London Electric Lighting Station at Bankside, some of which are shown in the accompanying figures.

Fig. 3 represents the electromotive force curve of a Mordey alternator on full load, the load being a water resistance. It will be seen that the curve of electromotive force is not very far from a simple periodic or simple sine curve as shown in Fig. 4. Fig. 5 shows the electromotive force curve of a larger Mordey alternator at no load, and Fig. 6 shows the manner in which the electromotive force curve, at no load, is related to the position of the pole piece represented by the rectangular line. The electromotive force curve of an alternator is, however, not by any means always so nearly a simple periodic curve. Fig. 7 represents the electromotive curve of a Thomson-Houston alternator taken at no load, the position of the field poles with respect to the electromotive curve being shown by the square rectangles in the figure. Fig. 8 shows the electromotive force curve of the same machine when working on a highly inductive load of transformers. In order to determine the form and relative position of the current curve, all that it is necessary to do is to put in series with the alternator circuit a non-inductive resistance sufficient to carry without sensible heating the outgoing current. By connecting the revolving contact breaker and associated voltmeter with the terminals of this non-inductive resistance we can delineate the curve of fall of potential down the non-inductive resistance, which is identically the same thing as the curve of current in the resistance.

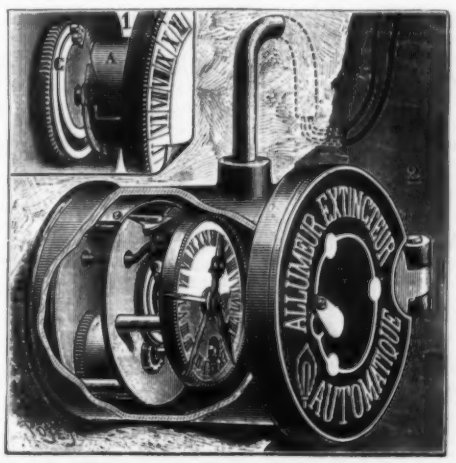
In this manner have been determined the current curves taken from the above mentioned machines, both on inductive and non-inductive loads. Fig. 9 shows the electromotive force curve and part of the current curve of a Mordey and Thomson-Houston alternator on a water resistance; and Fig. 10 shows the current curve and part of the electromotive force curve of a Thomson-Houston alternator working on a water resistance. These diagrams show that when an alternator, having an electromotive force of 2,000 volts, is working on a water resistance this load is an absolutely non-inductive load, the current curve being practically perfectly in step with the electromotive force.

(To be continued.)

* For further details see "The Alternate Current Transformer." Fleming, vol. i (new edition), p. 321.

AUTOMATIC LIGHTER AND EXTINGUISHER.

ALMOST all of the distributions of electric energy in large cities use meters; but there are a large number



THE HERMAND AUTOMATIC LIGHTER AND EXTINGUISHER.

1. View of the commutator. 2. General view of the interior.

of works in mountainous districts, in places where waterfalls are utilized and in towns where there are small central stations in which it is impossible to employ meters without increasing the expenses of exploitation out of measure. In such cases a contract is made with the consumer and an automatic lighter and extinguisher is used. Such apparatus are well known and very numerous, but we desire to call the attention of our readers to that of Mr. Hermand, which we have had under observation for several years and which has really given very satisfactory results. Number 2 of the accompanying figure gives a general view of the interior of the apparatus. To the back plate there is fixed an insulating disk with which is connected a clockwork movement that actuates a special commutator. In front there is a dial divided inio 24 hours, and upon which there are arranged hands for marking the hours, as well as two other hands that are connected directly with the commutator. The latter consists of two concentric cylinders, A and B (No. 1), that are insulated from each other, and are, through strips of copper, made to communicate, according to the hour, with the lighting circuits coming from the exterior. In fact, one of the cylinders corresponds to the lighting and the other to the extinguishing hand. It suffices to place the hands at the proper hours to have the lamps lighted or extinguished with precision.

The apparatus is strong and substantial and is placed in a cast iron case that may be fixed directly to the wall, as shown in our figure. The wires coming from the circuit are connected with terminals upon the back plate. The apparatus is capable of operating from fifteen to thirty days without rewinding. There are some apparatus which even run two months. Mr. Hermand, in utilizing the same principle, has adapted to his apparatus current limiters which do not allow the subscriber to exceed a certain intensity without having notified the works, and also relay apparatus that permit, on the contrary, of reaching an intensity greater than the normal one. A registering apparatus also has been added to some of the apparatus so as to allow every variation to be followed at the house of the subscriber.—La Nature.

ELECTRICITY IN THE THEATER.

THE stage effects obtained in theaters by means of electricity are numerous. It is possible, in fact, to vary them to infinity, and there is, so to speak, no great spectacular piece that does not lay some of them under contribution.

We propose at present to call attention to two of them, not that they are new (the first especially), but in order to give an idea of the resources that electricity is capable of furnishing in the putting of a piece upon the stage. It is a question in the first place of a sunrise and in the second of the explosion of a bomb.

Upon a stage lighted with incandescent footlights

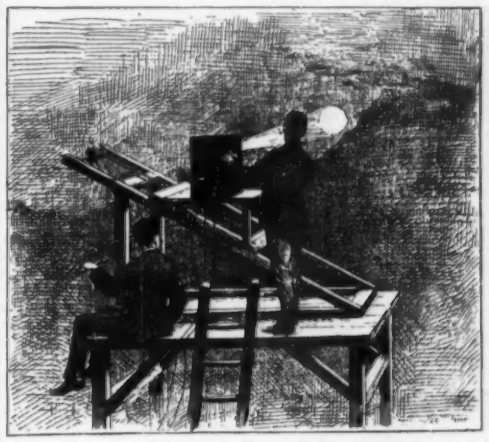


FIG. 1.—SUNRISE EFFECT.

that are capable, through mechanical arrangements, of being covered with screens that give the light the necessary colors, while commutators permit of obtaining graduated intensities, let us suppose we have some heavy drama in which, for example, an event of the highest importance is to take place at sunrise, say the shooting of prisoners of war or of spies; the idea at once occurs to the stage setter to follow point by point Rousseau's fine description of a sunrise: "It is seen announcing itself from afar by flashes of fire." At first a faint red glimmer tinges the sky of the scenery, and the light progressively increases until the entire horizon is embraced.

A broad red disk, a glowing sun, emerges from behind the mountain, and, as it rises, progressively loses its color and finally appears shining with its natural white light. The effects may be so powerful and so real as to make it difficult for the spectators to be convinced that they are but an illusion produced by electricity.

Let us now pass into the side scenes and see how these effects are obtained. A semicircular screen placed across the stage forms the background of the mountains. Upon a platform behind the center of this screen is placed an arc projector that is maneuvered by hand and connected with an incandescent light circuit of 100 volts, and that throws a luminous disk upon the canvas of the screen.

Above the stage are suspended colored incandescent border lights. In other suitable places there are arranged groups of lamps provided with reflectors of special form, and that may be introduced successively into the circuit. Colored gelatine plates may be slid over the face of the reflectors so as to give the light the color desired.

The electrician first puts into the circuit the groups of lamps that produce blue light, as well as the blue and white border lights, in order to obtain the grayish blue glimmer of morning. At a signal given him, the man in charge of the arc lamp places a red glass in front of the lenses of the projector and causes the current to pass, the luminous disk being directed upon the back of the mountain, out of sight of the spectators. A group of red lamps is lighted and the resistances are succes-

FIG. 2.—BOMB EXPLOSION EFFECT.

sively withdrawn so as to heighten the red light of the rising sun. The groups of lamps with gelatine plate are used for reinforcing the light, according to requirements.

At the same time an assistant turns a winch (Fig. 1), in order to cause the slow ascent of the arc lamp, which slides upon an inclined plane, whence results a like motion of the luminous disk upon the screen. After the sun has risen above the mountain the red light is diminished, the red glass placed before the aperture of the projector is gradually removed and white lamps are successively put into the circuit until the sun being at its full, there is no longer anything but white light. These excellent results have been obtained only after a

long study and numerous experiments. The slightest fault in the maneuvering or an error in the signaling would cause a complete failure.

The second effect of which we are to speak also produces a perfect illusion. In the midst of a desperate battle a shell falls and bursts upon the stage. Fig. 2 shows the arrangement that permits of obtaining this result. A papier maché shell formed of separate pieces glued together contains the quantity of powder strictly sufficient to separate the pieces and produce the bursting. In the powder there is an electric primer which is ignited by a current of three amperes and which is connected by wires, on the one hand, with an interrupter and, on the other, with the main conductor of the lighting circuit of the theater. At one of the sides of the stage, out of sight of the spectators, there is a small cannon whose charge is ignited in the same way and by means of the same interrupter. At the proper moment a man throws the shell. The latter bursts, and the spectators, hearing the loud explosion of the cannon at the same instant, imagine that the harmless cardboard envelope is the cause of the formidable detonation.—La Science en Famille.

AN INTERRUPTED STITCH BY A CONTINUOUS METHOD.*

By Campbell Ford, M.D.

The perfect suturing of a wound contemplates the coaptation and retention of the divided structures to their normal relations. A suture, in addition to fulfilling this requirement, should cause no disturbance, per se, be easily and rapidly inserted, and permit of being removed from any point without disturbing any other part of the wound.

The Czerny, Lembert, cobbler's, button, mattress, subcutaneous, pin, rubber, and the quilled are special sutures, fulfilling certain special requirements. Practically, the "glover's," or continuous, and the interrupted are the ones used.

The "glover's" has the advantages of being rapidly and easily inserted, requiring only a small amount of thread, with the disadvantages that the action of the force is not at right angles to the cut surface as it should be, but is lengthwise, causing a tendency to pull and pucker the edges. The surfaces are gathered in a roll with the suture wrapped around it, producing interference with the circulation of blood and lymph, at the line of union, where it should be free. If the suture cuts or gives way at any point, the entire wound opens, nor can it be removed at any point without the same result.

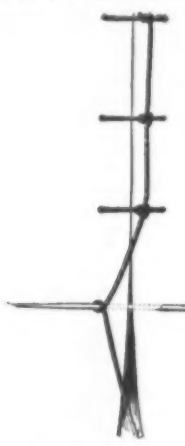


Fig. 1.—Showing the First Turn.

Fig. 2.—Showing the Second Turn.

From the clinical results, the interrupted suture has been the most popular one with nearly every surgeon, due to the fact that it fulfills more nearly the scientific requirements. Force is exerted at right angles to the wound, operating at the best advantage, less force is required, therefore producing less disturbance. Each stitch may be adjusted or removed separately and the circulation between the stitches is not impaired.

The disadvantages are that cut ends are points of irritation when it is used as a buried suture. This has caused it to be rejected by some in operations for the radical cure of hernia, and in fact, in all operations where a buried suture is required. If the ends are cut short they will untie, and if cut long, increase irritation. Far more material is lost than is used. This becomes an item of importance with the expensive prepared materials. The chief objection is the time lost in measuring, cutting, gathering, tying, and the subsequent clipping of the ends of the suture, together with the threading and changing of needles.

To overcome these objections I have devised and successfully used the following method: Use a long thread. Pass the needle through the divided structures and, without cutting, tie a reef knot. For the second stitch pass the needle from right to left, thrusting the point well through and, just before grasping it, to draw it on through, pick up the thread near the former knot and turn from right to left around the point of the needle. Once around for a reef or square and twice around for a surgeon's knot. Draw the needle on through and adjust the tension. This forms the first loop of a reef knot or, if two turns have been made, a surgeon's knot. Pass the needle from left to right under the strand between the two knots, drawing it out through the loop formed. This completes the knot. [See Figs. 1 and 2.]

The universal direction for every position away from you, left or right handed, is, form the first loop by turning the thread toward the eye or heel of the needle and around under the point. Draw the needle on through and adjust the tension. Complete the knot by passing the needle under the thread between the knot, in the opposite direction from which it was inserted into the tissues.

The first step may be slightly modified by passing the needle around the thread instead of the thread around the needle.

Here all the advantages of both the continuous and the interrupted sutures are combined, with none of the disadvantages of either. In addition, by using the thread as a guy line, the last stitch may be readily located. The cut edges cannot retract and be lost as a peritoneum, fascia, or muscle may.

It is simplicity itself. Careful computation shows that it can be introduced in one-sixth of the time required for the interrupted suture, and with little practice may be introduced almost as fast as the glover's.

The first loop will not slip, no material is wasted, no assistance is necessary, no slippery tangled ends, no changing and threading of needles, no tension lengthwise, no cut ends to irritate, the knot cannot untie, each stitch is adjusted, tied, and may be removed separately; circulation between the stitches is not interfered with, all the force exerted is just sufficient to close the wound, as it operates at the best advantage, i. e., at right angles to the cut surfaces.

Wherever suturing is required, and especially for uniting hollow viscera, the different planes in closing the abdomen, and where immediate and perfect union is required, as in Stinson's, Bassini's, Halstead's, and other æsthetic operations for radical cure of hernia, this method is particularly adapted to supplant the crude and dangerous cobbler stitch recommended by Marcy, of Boston, the wire of Halstead, the inefficient glover's, the slowly introduced interrupted with the points of irritation, or, in fact, any other stitch or method yet devised.

* Read before the San Francisco County Medical Society, June 9, 1896. —Reprinted from Pacific Medical Journal, July, 1896.

RELATION OF MEDICINE AND PURE SCIENCE.*

I propose on the present occasion to bring before you some illustrations of the interdependence of science and the healing art; and the first that I will take is, perhaps, the most astonishing of all results of purely physical inquiry—the discovery of the Roentgen rays. We can all appreciate their power of passing through substances opaque to ordinary light. They produce the same effects as light upon a photographic plate. As a rule, the denser any object is, the greater obstacle does it oppose to the rays. Thus a picture is obtained in which the bones stand out in sharp relief among the flesh, and anything abnormal in their shape or position is clearly displayed.

This must give important aid to the surgeon. Mr. Howard Marsh was called to see a severe injury of the elbow, in which the swelling was so great as to make it impossible for him by ordinary means of examination to decide whether he had to deal with a fracture or a dislocation. If it were the latter, a cure would be effected by the exercise of violence which would be not only useless but most injurious if a bone was broken. By the aid of the Roentgen rays a photograph was taken in which the bone of the upper arm was clearly seen displaced forward on those of the forearm. The diagnosis being thus established, Mr. Marsh proceeded to reduce the dislocation; and his success was proved by another photograph which showed the bones in their natural relative position.

Metals being denser than the osseous structures, these rays can show a bullet embedded in a bone, or a needle lodged about a joint. At the last conversazione of the Royal Society a picture produced by the new photography displayed with perfect distinctness through the bony framework of the chest a halfpenny low down in a boy's gullet. It had been there for six months, and its position was entirely uncertain till the Roentgen rays revealed it. The surgeon in charge of the case made an attempt to extract it. This had the effect of dislodging the coin. A subsequent photograph showed that it had disappeared from the gullet, and proved that it had not lodged further down. The boy has since completely recovered.

The Roentgen rays cause certain chemical compounds to fluoresce, and emit a faint light plainly visible in the dark; and if they are made to fall upon a translucent screen impregnated with such a salt, it becomes beautifully illuminated. If a part of the human body is interposed between the screen and the source of the rays, the bones and other structures are thrown in shadow upon it, and thus a diagnosis can be made without the delay involved in taking a photograph. By virtue of the great density of the heart, that organ may be displayed on the fluorescent screen, and even its movements have been lately seen.

This is the jubilee of anæsthesia in surgery. On September 30, 1846, Dr. W. T. G. Morton, of Boston, after a series of experiments upon himself and the lower animals, extracted a tooth painlessly from a patient whom he had caused to inhale the vapor of sulphuric ether. He soon afterward publicly exhibited his method at the Massachusetts General Hospital, and after that event the great discovery spread rapidly over the civilized world.

Anæsthesia in surgery has been from first to last a gift of science. Nitrous oxide, sulphuric ether, and chloroform are all artificial products of chemistry; their employment as anæsthetics was the result of scientific investigation.

My next illustration may be taken from the work of Pasteur on fermentation. The prevailing opinion regarding this class of phenomena when they first engaged his attention was that they were occasioned primarily by the oxygen of the air acting upon unstable animal or vegetable products, which, breaking up under its influence, communicated disturbance to other organic materials in their vicinity, and thus led to their decomposition. Cagniard-Latour had shown several years before that yeast consists essentially of the cells of a microscopic fungus which grows as the sweetwort ferments; and he had attributed the breaking up of the sugar into alcohol and carbonic acid to the growth of the micro-organism.

Pasteur, having been appointed as a young man dean of the faculty of sciences in the University of Lille, a town where the products of alcoholic fermentation were staple articles of manufacture, determined to study that process thoroughly; and as a result he became firmly convinced of the correctness of Cagniard-Latour's views regarding it. In the case of other fermentations, however, nothing fairly comparable to the formation of yeast had till then been observed. This was now done by Pasteur for that fermentation in which sugar is resolved into lactic acid. This lactic fermentation was at that time brought about by adding some animal substance, such as fibrin, to a solution of sugar, together with chalk that should combine with the acid as it was formed. Pasteur saw, what had never before been noticed, that a fine gray deposit was formed, differing little in appearance from the decomposing fibrin, but steadily increasing as the fermentation proceeded. Struck by the analogy presented by the increasing deposit to the growth of yeast in sweetwort, he examined it with the microscope, and found it to consist of minute particles of uniform size. Pasteur was not a biologist, but although these particles were of extreme minuteness in comparison with the constituents of the yeast plant, he felt convinced that they were of an analogous nature, the cells of a tiny microscopic fungus. This he regarded as the essential ferment, the fibrin or other so-called ferment serving, as he believed, merely the purpose of supplying to the growing plant certain chemical ingredients not contained in the sugar but essential to its nutrition. And the correctness of this view he confirmed in a very striking manner, by doing away with the fibrin or other animal material altogether, and substituting for it mineral salts containing the requisite chemical elements. A trace of the gray deposit being applied to a solution of sugar containing these salts in addition to the chalk, a brisker lactic fermentation ensued than could be obtained in the ordinary way.

A series of other beautiful investigations followed, clearly proving that all true fermentations, including putrefaction, are caused by the growth of micro-organisms.

Pasteur pointed out the enormous importance of these humble organisms in the economy of nature. It is by their agency that the dead bodies of plants and animals are resolved into simpler compounds fitted for assimilation by new living forms. Without their aid the world would be, as Pasteur expresses it, encombré de cadavres. They are essential not only to our well being, but to our very existence.

Pasteur's labors on fermentation have had a very important influence upon surgery. I have been often asked to speak on my share in this matter before a public audience; but I have hitherto refused to do so, partly because the details are so entirely technical, but chiefly because I have felt an invincible repugnance to what might seem to savor of self-advertisement. The latter objection now no longer exists, since advancing years have indicated that it is right for me to leave to younger men the practice of my dearly loved profession. And it will, perhaps, be expected that, if I can make myself intelligible, I should say something upon the subject on the present occasion.

Nothing was formerly more striking in surgical experience than the difference in the behavior of injuries according to whether the skin was implicated or not. Thus, if the bones of the leg were broken and the skin remained intact, the surgeon applied the necessary apparatus without any other anxiety than that of maintaining a good position of the fragments, although the internal injury to bones and soft parts might be very severe. If, on the other hand, a wound of the skin was present communicating with the broken bones, although the damage might be in other respects comparatively slight, the compound fracture, as it was termed, was one of the most dangerous accidents that could happen.

It will be readily understood that the inflammation which so often frustrated the surgeon's endeavors after primary union was, in my opinion, essentially due to decomposition of blood within the wound.

These and many other considerations had long impressed me with the greatness of the evil of putrefaction in surgery. I had done my best to mitigate it by scrupulous ordinary cleanliness and the use of various deodorant lotions. But to prevent it altogether appeared hopeless while we believed with Liebig that its primary cause was the atmospheric oxygen which, in accordance with the researches of Graham, could not fail to be perpetually diffused through the porous dressings which were used to absorb the blood discharged from the wound. But when Pasteur had shown that putrefaction was a fermentation caused by the growth of microbes, and that these could not arise de novo in the decomposable substance, the problem assumed a more hopeful aspect. If the wound could be treated with some substance which, without doing too serious mischief to the human tissues, would kill the microbes already contained in it and prevent the future access of others in the living state, putrefaction might be prevented, however freely the air with its oxygen might enter. I had heard of carbolic acid as having a remarkable deodorizing effect upon sewage, and having obtained from my colleague Dr. Anderson,

* Abstract of inaugural address delivered at the Liverpool meeting of the British Association and published in Nature, by Sir Joseph Lister, Bart., D.C.L., LL.D., P.R.S., President.

professor of chemistry in the University of Glasgow, a sample which he had of this product, then little more than a chemical curiosity in Scotland, I determined to try it in compound fractures. Applying it undiluted to the wound, with an arrangement for its occasional renewal, I had the joy of seeing these formidable injuries follow the same safe and tranquil course as simple fractures, in which the skin remains unbroken.

At the same time we had the intense interest of observing in open wounds what had previously been hidden from human view, the manner in which subcutaneous injuries are repaired. Of special interest was the process by which portions of tissue, killed by the violence of the accident, were disposed of, as contrasted with what had till then been invariably witnessed. Dead parts had been always seen to be gradually separated from the living by an inflammatory process and thrown off as sloughs. But when protected by the antiseptic dressing from becoming putrid and therefore irritating, a structure deprived of its life caused no disturbance in its vicinity; and, on the contrary, being of a nutritious nature, it served as pabulum for the growing elements of the neighboring living structures, and these became in due time entirely substituted for it. Even dead bone was seen to be thus replaced by living osseous tissue.

This suggested the idea of using threads of dead animal tissue for tying blood vessels; and this was realized by means of catgut, which is made from the intestine of the sheep. If deprived of living microbes and otherwise properly prepared, catgut answers its purpose completely; the knot holding securely, while the ligature around the vessel becomes gradually absorbed and replaced by a ring of living tissue. The threads, instead of being left long as before, could now be cut short, and the tedious process of separation of the ligature, with its attendant serious danger of bleeding, was avoided.

Undiluted carbolic acid is a powerful caustic; and, although it might be employed in compound fracture where some loss of tissue was of little moment in comparison with the tremendous danger to be averted, it was altogether unsuitable for wounds made by the surgeon. It soon appeared, however, that the acid would answer the purpose aimed at, though used in diluted forms devoid of caustic action, and, therefore, applicable to operative surgery. According to our then existing knowledge, two essential points had to be aimed at—to conduct the operation so that on its completion the wound should contain no living microbes and to apply a dressing capable of preventing the access of other living organisms till the time should have arrived for changing it.

Carbolic acid lent itself well to both these objects. Our experience with this agent brought out what was, I believe, a new principle in pharmacology—namely, that the energy of action of any substance upon the human tissues depends not only upon the proportion in which it is contained in the material used as a vehicle for its administration, but also upon the degree of tenacity with which it is held by its solvent. Water dissolves carbolic acid sparingly and holds it extremely lightly, leaving it free to act energetically on other things for which it has greater affinity, while various organic substances absorb it greedily and hold it tenaciously. Hence its watery solution seemed admirably suited for a detergent lotion to be used during the operation for destroying any microbes that might fall upon the wound, and for purifying the surrounding skin and also the surgeon's hands and instruments. For the last named purpose it had the further advantage that it did not act on steel.

For an external dressing the watery solution was not adapted, as it soon lost the acid it contained, and was irritating while it lasted. For this purpose some organic substances were found to answer well. Large proportions of the acid could be blended with them in so bland a form as to be unirritating; and such mixtures, while perpetually giving off enough of the volatile salt to prevent organic development in the discharges that flowed past them, served as a reliable store of the antiseptic for days together.

The appliances which I first used for carrying out the antiseptic principle were both rude and needlessly complicated. The years that have since passed have witnessed great improvements in both respect of the various materials which have been employed by myself and others and their modes of application. I need say nothing except to express my belief, as a matter of long experience, that carbolic acid, by virtue of its powerful affinity for the epidermis and oily matters associated with it, and also its great penetrating power, is still the best agent at our disposal for purifying the skin around the wounds. But I must say a few words regarding a most important simplification of our procedure. Pasteur, as we have seen, had shown that the air of every inhabited room teems with microbes; and for a long time I employed various more or less elaborate precautions against the living atmospheric dust, not doubting that, as all wounds except the few which healed completely by the first intention underwent putrefactive fermentation, the blood must be a peculiarly favorable soil for the growth of putrefactive microbes. But I afterward learned that such was by no means the case. I had performed many experiments in confirmation of Pasteur's germ theory, not indeed in order to satisfy myself of its truth, but in the hope of convincing others. I had observed that uncontaminated milk, which would remain unaltered for an indefinite time if protected from dust, was made to teem with microbes of different kinds by a very brief exposure to the atmosphere, and that the same effect was produced by the addition of a drop of ordinary water. But when I came to experiment with blood drawn with antiseptic precautions into sterilized vessels, I saw to my surprise that it might remain free from microbes in spite of similar access of air or treatment with water. I even found that if very putrid blood was largely diluted with sterilized water, so as to diffuse its microbes widely and wash them of their acrid products, a drop of such dilution added to pure blood might leave it unchanged for days at the temperature of the body, although a trace of the septic liquid undiluted caused intense putrefaction within twenty-four hours. Hence I was led to conclude that it was the grosser forms of septic mischief, rather than microbes in the attenuated condition in which they existed in the atmosphere, that we had to dread in surgical practice. And at the London Medical Congress in 1881, I hinted, when describing the experiments I have alluded to, that it might turn out possible to disregard altogether the atmospheric dust. But greatly as I should have rejoiced at such a simplification of our procedure, if justifiable, I did not then venture to test it in practice. I knew that with the safeguards which we then employed I could insure the safety of my patients, and I did not dare to imperil it by relaxing them. There is one golden rule for all experiments upon our fellowmen. Let the thing tried be that which, according to our best judgment, is the most likely to promote the welfare of the patient. In other words, Do as you would be done by.

Nine years later, however, at the Berlin Congress in 1890, I was able to bring forward what was, I believe, absolute demonstration of the harmlessness of the atmospheric dust in surgical operations. This conclusion has been justified by subsequent experience: the irritation of the wound by antiseptic irrigation and washing may therefore now be avoided, and nature left quite undisturbed to carry out her best methods of repair, while the surgeon may conduct his operations as simply as in former days, provided always that, deeply impressed with the tremendous importance of his object, and inspiring the same conviction in all his assistants, he vigilantly maintains from first to last, with a care that, once learnt, becomes instinctive, but for the want of which nothing else can compensate, the use of the simple means which will suffice to exclude from the wound the coarser forms of septic impurity.

Even our earlier and ruder methods of carrying out the antiseptic principle soon produced a wonderful change in my surgical wards in the Glasgow Royal Infirmary, which, from being some of the most unhealthy in the kingdom, became, as I believe I may say without exaggeration, the healthiest in the world; while other wards, separated from mine only by a passage a few feet broad, where former modes of treatment were for a while continued, retained their former insalubrity. This result, I need hardly remark, was not in any degree due to special skill on my part, but simply to the strenuous endeavor to carry out strictly what seemed to me a principle of supreme importance.

The first rational step toward the prevention or cure of disease is to know its cause; and it is impossible to overestimate the practical value of researches such as those to which I am now referring. Among their many achievements is what may be fairly regarded as the most important discovery ever made in pathology, because it revealed the true nature of the disease which causes more sickness and death in the human race than any other. It was made by Robert Koch, who greatly distinguished himself when a practitioner in an obscure town in Germany, by the remarkable combination of experimental acuteness and skill, chemical and optical knowledge and successful microphotography which he brought to bear upon the illustration of infective diseases of wounds in the lower animals; in recognition of which service the enlightened Prussian government at once appointed him to an official position of great importance in Berlin. There he conducted various important researches; and at the London congress, in 1881, he showed to us for the first time the bacillus of tubercle. Wonderful light was thrown by this discovery upon a great group of diseases which had before been rather guessed than known to be of an allied nature; a precision and efficacy never before possible was introduced into their surgical treatment, while the physician became guided by new and sure light as regards their diagnosis and prevention.

At that same London congress Koch demonstrated to us his "plate culture" of bacteria, which was so important that I must devote a few words to its description. With a view to the successful study of the habits and effects of any particular microbe outside the living body, it is essential that it should be present unmixed in the medium in which it is cultivated. It can be readily understood how difficult it must have been to isolate any particular micro-organism when it existed mixed, as was often the case with a multitude of other forms. In fact, the various ingenious attempts made to effect this object had often proved entire failures. Koch, however, by an ingenious procedure converted what had been before impossible into a matter of utmost facility. In the broth or other nutrient liquid which was to serve as food for the growing microbe he dissolved, by the aid of heat, just enough gelatine to insure that, while it should become a solid mass when cold, it should remain fluid, though reduced in temperature so much as to be incapable of killing living germs. To the medium thus partially cooled was added some liquid containing among others the microbe to be investigated; and the mixture was thoroughly shaken so as to diffuse the bacteria and separate them from each other. Some of the liquid was then poured out in a thin layer upon a glass plate and allowed to cool, so as to assume the solid form. The various microbes, fixed in the gelatine and so prevented from intermingling, proceeded to develop each its special progeny, which in course of time showed itself as an opaque speck in the transparent film. Any one of such specks could now be removed and transferred to another vessel in which the microbe composing it grew in perfect isolation.

Pasteur was present at this demonstration, and expressed his sense of the great progress effected by the new method. It was soon introduced into his own institute and other laboratories throughout the world; and it has immensely facilitated bacteriological study.

One fruit of it in Koch's own hands was the discovery of the microbe of cholera in India, whither he went to study the disease. This organism was termed by Koch from its curved form the "comma bacillus," and by the French the cholera vibrio. Great doubts were for a long time felt regarding this discovery. Several other kinds of bacteria were found of the same shape, some of them producing very similar appearances in culture media. But bacteriologists are now universally agreed that, although various other conditions are necessary to the production of an attack of cholera besides the mere presence of the vibrio, yet it is the essential materies morbi; and it is by the aid of the diagnosis which its presence in any case of true cholera enables the bacteriologist to make that threatened invasions of this awful disease have of late years been so successfully repelled from our shores. If bacteriology had done nothing more for us than this, it might well have earned our gratitude.

I have next to invite your attention to some earlier work of Pasteur. There is a disease known in France under the name of choléra des poules, which often produced great havoc among the poultry yards of Paris. It had been observed that the blood of birds that had died of this disease was peopled by a multitude of minute bacteria, not very dissimilar in form and size to the microbe of the lactic ferment to which I have before referred. And Pasteur found that, if this bacterium was cultivated outside the body for a protracted period under certain conditions, it underwent a remarkable diminution of its virulence; so that, if inoculated into a healthy fowl, it no longer caused the death of the bird, as it would have done in its original condition, but produced a milder form of the disease which was not fatal. And this altered character of the microbe, caused by certain conditions, was found to persist in successive generations cultivated in the ordinary way. Thus was discovered the great fact of what Pasteur termed the atténuation des virus, which at once gave the clew to understanding what had before been quite mysterious, the difference in virulence of the same disease in different epidemics.

But he made the further very important observation that a bird which had gone through the mild form of the complaint had acquired immunity against it in its most virulent condition. Pasteur afterward succeeded in obtaining mitigated varieties of microbes for some other diseases; and he applied with great success the principle which he had discovered in fowl cholera for protecting the larger domestic animals against the plague of anthrax. The preparations used for such preventive inoculations he termed "vaccins," in honor of our great countryman Edward Jenner. For Pasteur at once saw the analogy between the immunity to fowl cholera produced by its attenuated virus and the protection afforded against smallpox by vaccination. And while pathologists still hesitated, he had no doubt of the correctness of Jenner's expression variolæ vaccinæ, or smallpox in the cow.

It is just a hundred years since Jenner made the crucial experiment of inoculating with smallpox a boy whom he had previously vaccinated, the result being, as he anticipated, that the boy was quite unaffected. It may be remarked that this was a perfectly legitimate experiment, involving no danger to the subject of it. Inoculation was at that time the established practice; and if vaccination should prove nugatory, the inoculation would be only what would have been otherwise called for; while it would be perfectly harmless if the hoped for effect of vaccination had been produced.

But to return to Pasteur. In 1880 he entered upon the study of that terrible but then most obscure disease, hydrophobia or rabies, which from its infective character he was sure must be of microbic origin, although no micro-organism could be detected in it. He early demonstrated the new pathological fact that the virus had its essential seat in the nervous system. This proved the key to his success in this subject. One result that flowed from it has been the cause of unspeakable consolation to many. The foolish practice is still too prevalent of killing the dog that has bitten any one, on the absurd notion that, if it were mad, its destruction would prevent the occurrence of hydrophobia in the person bitten. The idea of the bare possibility of the animal having been so affected causes an agony of suspense during the long weeks or months of possible incubation of the disease. Very serious nervous symptoms aping true hydrophobia have been known to result from the terror thus inspired. Pasteur showed that if a little of the brain or spinal cord of a dog that had been really mad was inoculated in an appropriate manner into a rabbit, it infallibly caused rabies in that animal in a few days. If, therefore, such an experiment was made with a negative result, the conclusion might be drawn with certainty that the dog had been healthy.

It was shown several years ago by Roux and Yersin, working in the Institut Pasteur, that the crust or false membrane which forms upon the throats of patients affected with diphtheria contains bacteria which can be cultivated outside the body in a nutrient liquid, with the result that it acquires poisonous qualities of astonishing intensity, comparable to that of the secretion of the poison glands of the most venomous serpents. And they also ascertained that the liquid retained this property after the microbes had been removed from it by filtration, which proved that the poison must be a chemical substance in solution, as distinguished from the living element which had produced it. These poisonous products of bacteria, or toxins, as they have been termed, explain the deadly effects of some microbes, which it would otherwise be impossible to understand. Thus, in diphtheria itself the special bacillus which was shown by Löffler to be its cause does not become propagated in the blood, like the microbe of chicken cholera, but remains confined to the surface on which it first appeared; but the toxin which it secretes is absorbed from that surface into the blood, and so poisons the system. Similar observations have been made with regard to the microbes of some other diseases, as, for example, the bacillus of tetanus or lockjaw. This remains localized in the wound, but forms a special toxin of extreme potency, which becomes absorbed and diffused through the body.

It has been ascertained that glanders presents a precise analogy with tubercle as regards the effects of its toxic product. If the microbe which has been found to be the cause of this disease is cultivated in appropriate media, it produces a poison which has received the name of mallein, and the subcutaneous injection of a suitable dose of this fluid into a glandered horse causes striking febrile symptoms which do not occur in a healthy animal. Glanders, like tubercle, may exist in insidious latent forms which there was formerly no means of detecting, but which are at once disclosed by this means. If a glandered horse has been accidentally introduced into a large stable, this method of diagnosis surely tells if it has infected others. All receive a little mallein. Those which become affected with fever are slaughtered, and thus not only is the disease prevented from spreading to other horses, but the grooms are protected from a mortal disorder.

I have, lastly, to bring before you a subject which, though not bacteriological, has intimate relations with bacteria. If a drop of blood is drawn from the finger by a prick with a needle and examined microscopically between two plates of glass, there are seen in it minute solid elements of two kinds, the one pale orange biconcave disks, which, seen in mass, give the red

color to the vital fluid, the other more or less granular spherical masses of the soft material called protoplasm, destitute of color, and therefore called the colorless or white corpuscles.

These white corpuscles have been invested with extraordinary new interest by the researches of the Russian naturalist and pathologist Metchnikoff. He observed that, after passing through the walls of the vessels, they not only crawl about like amœbæ, but, like them, receive nutritious materials into their soft bodies and digest them. It is thus that the effete materials of a tadpole's tail are got rid of; so that they play a most important part in the function of absorption.

But still more interesting observations followed. He found that a microscopic crustacean, a kind of water flea, was liable to be infested by a fungus which had exceedingly sharp pointed spores. These were apt to penetrate the coats of the creature's intestine, and project into its body cavity. No sooner did this occur with any spore than it became surrounded by a group of the cells which are contained in the cavity of the body and correspond to the white corpuscles of our blood. These proceeded to attempt to devour the spore; and if they succeeded, in every such case the animal was saved from the invasion of the parasite. But if the spores were more than could be disposed of by the devouring cells (phagocytes, as Metchnikoff termed them), the water flea succumbed.

Starting from this fundamental observation, he ascertained that the microbes of infective diseases are subject to this same process of devouring and digestion, carried on both by the white corpuscles and by cells that line the blood vessels. And by a long series of most beautiful researches he has, as it appears to me, firmly established the great truth that phagocytosis is the main defensive means possessed by the living body against the invasions of its microscopic foes. The power of the system to produce antitoxic substances to counteract the poisons of microbes is undoubtedly in its own place of great importance. But in the large class of cases in which animals are naturally refractory to particularly infective diseases the blood is not found to yield any antitoxic element by which the natural immunity can be accounted for. Here phagocytosis seems to be the sole defensive agency. And even in cases in which the serum does possess antitoxic, or, as it would seem in some cases, germicidal properties, the bodies of the dead microbes must at last be got rid of by phagocytosis, and some recent observations would seem to indicate that the useful elements of the serum may be, in part at least, derived from the digestive juices of the phagocytes. If ever there was a romantic chapter in pathology, it has surely been that of the story of phagocytosis.

THE HUMAN BODY AS SHOWN BY THE ROENTGEN RAYS.

VERY remarkable results obtained by means of the Roentgen rays have lately attracted universal attention to this wonderful discovery. At the convention of naturalists held in Zurich, August 2 to 6, quite a sensation was caused by a demonstration of the power of these rays made by Prof. Zehnder, who had already become famous in work of this kind, and Mr. Kempke, the academic artist and photographer. An adult was rendered transparent by means of the Roentgen rays and the fluorescent screen so that the different internal organs, for instance, the heart, lungs and liver, could be plainly seen; and all this was fixed in a wonderfully clear photograph.

Prof. Ludwig Zehnder had produced a better and more durable tube which greatly facilitated the work and is more reliable in taking photographs than the tubes used before. In this way it became possible to take portions of the human body by means of larger plates placed at a greater distance from the tube and the sharpness of the picture was, of course, much improved by this distance. The tube was arranged exactly over the middle of the body about 23 inches from the dry plate on which the subject lay. In taking the head an exposure of 60 minutes was required; for the breast, 6 minutes; for the knee joints, 50 minutes; for the pelvis, 60 minutes; for the feet, arms and hands, 15 minutes each. By uniting these proofs a picture six feet six inches long was obtained. Our engraving is reduced from this photograph. The gentlemen who took part in the experiment hope, in future, to obtain still better results with even shorter exposures, for in making this first photograph much more importance was attached to proving beyond a doubt the possibility of making a photograph of the entire skeleton of a man by uniting separate plates than to the perfect matching of the bones, and, as will be seen, the different parts of the body were taken from different sides: the upper parts of the legs from one position and the lower parts from another; the upper part of the trunk from the back and the lower part from the front.

Dr. Dumstrey of Leipsic, who has given much attention to the latest experiments, expressed himself in regard to this picture as follows:

"The photograph before me shows, in a general way, the same results as those obtained in my experiments with the Roentgen rays at my Medico-Therapeutic Institute. I used an excellent apparatus which was furnished me by the Allgemeine Electricitatsgesellschaft of Berlin, and the tubes were also made in Berlin by Dr. Max Levy by order of the company. With the new tubes this apparatus produced almost the same picture as that shown in the photograph. All the parts of the body were penetrated by the Roentgen rays in all the experiments, so that an absolutely clear picture showing the construction of the skeleton of the subject was obtained; furthermore, the joints were all penetrated by the rays, so that the performance of their normal and abnormal functions could be observed, and the larger cavities were treated with almost equal success. With persons who are not too stout, the action of the heart and the other organs could be seen. The rays passed directly through the cavities of the skull, and every impenetrable foreign body was fixed positively.

"Compared with the first experiments with the Roentgen rays, all this shows great progress; for at first Roentgen himself was able to obtain photographs of certain subjects only after long exposures. The reason for this was that the tubes he used were most faulty; they were pear shaped and had only two electrodes, while the new tubes of the Allgemeine Electricitatsgesellschaft have three electrodes, two anodes and one cathode, that are so arranged in relation to one another that the cathode rays are collected on the central anode, which is provided with a platinum plate, and from there they are thrown outward. The invention of the fluorescent screen was, in my estimation, next in importance to Roentgen's discovery: this platino-cyanide of barium screen not only gives an image of the part of the body being viewed, in its condition at that time, but it also gives a constantly changing picture, showing all that is going on in that member, all movements and changes. We, therefore, see not only the needle in the finger when we place the latter between the rays and the screen, but also the pulsation of the heart, the way in which it expands and contracts, in a word, we see life.

"In closing, a few words in regard to my opinion—based on my own experiments—as to the value of this great discovery to the medical profession. In my estimation the Roentgen ray examinations will form a much more important factor in surgery than in the diagnosis of disease; in all cases where there is any doubt whether the physician has to deal with a fracture or a luxation, a glance at the fluorescent screen will decide the question in the simplest and clearest manner. After he has placed a bandage around a broken arm, he will assure himself that the parts of the broken bone are properly placed and that the bandage is in the right position, by means of the Roentgen apparatus; and when the bone has knit, he will be able to see whether everything is satisfactory by placing his patient before the screen."—Illustrirte Zeitung.

SKELETON OF A MAN SHOWN BY THE ROENTGEN RAYS.

From a photograph taken in sections and assembled by Prof. Zehnder and Mr. Kempke, of Freiburg i. Br.

Tiny, the smallest toy terrier in the world, died recently in London. He was less than four inches long. His late owner, Lieut.-Gen. St. Archibald Maclaine, has had the body stuffed and has presented it to the London Zoological Garden.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—The Development of Michigan Archæology.—By HARLAN I. SMITH.—Fast disappearing remains of prehistoric man in Michigan.—Proper methods of work to be adopted..... 17321

II. ASTRONOMY.—Neptune's Jubilee Year.—By Sir ROBERT HALL.—The fiftieth anniversary of the famous discovery of Neptune.—First installment of a popular article on the subject..... 17323

III. ELECTRICAL ENGINEERING.—Alternate Current Transformers.—By Dr. J. A. FLEMING.—Lecture I.—The first installment of a paper on the subject by a leading authority, with illustrations and diagrams of various curves.—10 illustrations..... 17329
Automatic Lighter and Extinguisher.—A clock for turning on and off the electric current for consumers' residences.—1 illustration..... 17331
Electricity in the Theater.—Some novel effects in electricity described as produced in theaters.—2 illustrations..... 17331

IV. MECHANICAL ENGINEERING.—Vertical and Horizontal Planing Machine.—A machine for slotting and planing, combining both functions without detriment to either.—1 illustration..... 17326

V. MEDICINE AND SURGERY.—An Interrupted Stitch by a Continuous Method.—By CAMPBELL FORD, M.D.—An elaborate description of a method of stitching wounds.—3 illustrations..... 17332
Relation of Medicine and Pure Science.—The interdependence of science and the healing art.—What the abstract researches of scientists have done for medical science..... 17332

VI. MISCELLANEOUS.—Suggestions in Wood Working for Amateurs.—A practical and well illustrated paper on woodworking, shaping and gluing.—4 illustrations..... 17329
The Capture of Elephants in Siam.—A popular article upon the capture and taming of wild elephants.—4 illustrations..... 17327
Note on London Omnibus Traffic..... 17329
Note on the Smallest Toy Terrier in the World..... 17332
Selected Formulæ..... 17334
Engineering Notes..... 17335
Electrical Notes..... 17335
Miscellaneous Notes..... 17336

VII. PHYSICS.—The Human Body as Shown by the Roentgen Rays.—Roentgen photograph of the entire human body from head to foot by combination of different plates.—1 illustration..... 17322

VIII. POLITICAL ECONOMY.—Commercial and Industrial Progress in Japan.—A very excellent paper on the manufacturing industries of the far East, with tables..... 17324

IX. TECHNOLOGY.—Apparatus for the Manufacture of Acetylene Gas.—III.—Continuation of this article on the different acetylene gas apparatus.—7 illustrations..... 17333
Preserving Glasses for Leather Workers, etc.—To finish the edges of books.—Numerous formulæ of preparations for bookbinders' use..... 17327
In a Flour Testing Laboratory.—Practical testing of flour by the technologist, with details of the methods..... 17326
The Simplex Ice Making Machine.—An ammonia absorption machine operated by steam.—1 illustration..... 17337

X. TRAVEL AND EXPLORATION.—Hong-Kong.—A description of the great Chinese city and of its botanical gardens.—1 illustration..... 17330
Jackson and Nansen in the White North.—Most interesting description of the romantic meeting of the two Arctic explorers, with portrait of Nansen and views.—3 illustrations..... 17319

BUILDING EDITION
OF THE
SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

MUNN & CO., 361 Broadway, New York.

CATALOGUES.

A Catalogue of Valuable Papers contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address; also, a comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *nearly fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—Nos. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.

ny
e a
the
ce,
ke-
ly,
.50
RI-
LE-
and
V.
AGE
17321
17328
17330
17331
17334
17336
17338
17339
17340
17341
17342
17343
17344
17345
17346
17347
17348
17349
17350
17351
17352
17353
17354
17355
17356
17357
17358
17359
ON
ail to
of a
rk.
n Sci-
st ten
com-
ferent
, has
t the
names
o ask
York.
S!
he pub-
examine
ace, and
rawings,
s in the
Co. also
Labels,
nts. All
ness, on
ll infer-
ecerning
gements,
rs, show-
countries
Building